OCT 15 1943

The Engineer

Vol. CLXXVI—No. 4575 28, ESSEX ST., STRAND, LONDON, W.C.2 SEPTEMBER 17, 1943

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper

SYMBOLS and SERVICE

"WE are symbols, and inhabit symbols; workmen, work and tools, words and things, birth and death, all are emblems." (Readers of Emerson's Essays will recall that fine and characteristic comment.) In all times, even the earliest, and in all parts of the earth, symbols have grown up like flowers. "We inhabit symbols."

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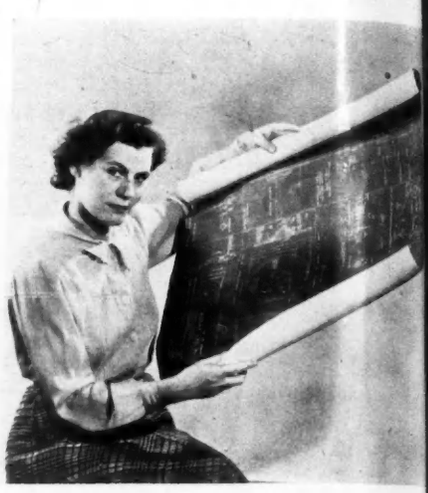

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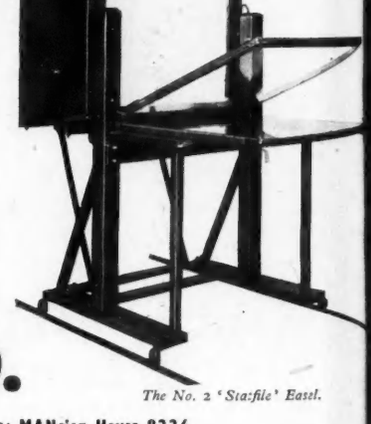

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LONDON, FRIDAY, SEPTEMBER 17, 1943.

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For continuation of Small Advertisements see page 56

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A Seven-Day Journal

The War Against U Boats

ON Friday evening, September 10th, another monthly statement dealing with the progress of the war against enemy submarines was issued by the Office of War Information and the Ministry of Information, after consultation with the British Admiralty, the United States Navy Department, and the Canadian Department of National Defence for Naval Services. It is revealed that August was another successful month in U-boat warfare. Owing perhaps to rearmament and other causes, there appear to have been fewer U boats at sea than in recent months, and shipping losses have continued to decrease. It is significant that the enemy made virtually no attempt to attack North Atlantic shipping, and opportunities for attacking the U boats were relatively few. Nevertheless, U boats were hunted relentlessly on all stations wherever they appeared, and a heavy toll was taken of the enemy. In fact, more U boats were sunk than merchant ships. Surface and air forces both contributed to this satisfactory month's work by the efficiency of their escorts, patrols, and offensive operations. Shore-based aircraft often had to face powerful enemy air opposition, and carrier-borne aircraft played a most important part.

The Repair of Damaged Aircraft

THE Minister of Aircraft Production, Sir Stafford Cripps, in a speech on Sunday, September 12th, gave some account of the work that is being done by aircraft repair establishments. Many aircraft, he said, underwent a number of repairs. One "Spitfire" had, in fact, been repaired nine times altogether and had had six new pairs of wings fitted. It had now gone back into service as good as when it was new. The speed of clearance of crashed aircraft was of the first importance. A damaged aeroplane might be blocking a runway or hindering the work of an aerodrome, railway, or road. Sir Stafford gave an instance of the speed with which the repair organisation operated in telling how a "Typhoon," in returning from a recent operation, belly-landed on an aerodrome. Half an hour afterwards a salvage gang had cleared the aerodrome and within seven hours the aeroplane had been dismantled and moved to the works for repair. It was very necessary that the repair depôts should be adequately supplied with spares of all descriptions, and that explained why the Ministry of Aircraft Production was continually urging the industry to keep up the output of spares, even though the output of completed aircraft might suffer a little as a result. The aeroplanes which came from the repair depôts were as good as any new aircraft of the same type. No pilot raised any objections to them, for he had learnt to trust the skill and accuracy of the managements, workers, and test pilots attached to the repair organisations. For every 100 airframes, engines, and propellers repaired in the first six months of 1940, Sir Stafford said that there were 1080 airframes, 945 engines, and 2207 propellers repaired in 1943. Taking the same two periods, the output of repaired aircraft in the first half of 1940 was only 13 per cent. of the new, whereas now it was 70 per cent., and it should be remembered that there had been a very large increase in the output of new aircraft.

Lord Weir's Fifty Years in Industry

AN interesting ceremony took place at the Cathcart works of G. and J. Weir, Ltd., Glasgow, on Friday, September 10th, when Lord Weir was presented with a certificate marking his fiftieth year with the firm. Other gifts he received included a gold watch from the directors and pieces of old Glasgow silver from the employees. There were present ten other recipients of the fifty years' service certificates. In order to celebrate the fiftieth anniversary of his joining the firm, Viscount Weir of Eastwood announced that he proposed to present the Victoria Infirmary, Glasgow, with £10,000 for the furtherance and development of the fracture clinic in the Infirmary. In returning thanks for the gifts made to him, Lord Weir said that, while he had to admit having been with the firm for fifty years, he felt still more eager to look forward than to dwell on the past. During his working life Britain had experienced two great wars. The first had been won, and the Allies were well on their way to victory in the second. He said that the post-war period would bring many important problems and that his younger colleagues were fully alive to the changes and revaluation which must take place, not only in the use of novel and complex materials for the specific needs of engineering, but with regard to the standard of life of the people, particularly housing. The important social experiments and their repercussions on labour would, he said, present problems to be solved by the brains and ingenuity of the new generation. The developments in aviation could not fail, Lord Weir said, to have an important influence on both shipbuilding and ship propulsion. No Government, Lord Weir concluded, could guarantee national or social security, but there was no reason why we should not earn those objectives by working diligently to realise them. In making the presentation on behalf of the directors, Sir John Richmond, the managing director of the company, said that Lord Weir began his apprenticeship on September 13th, 1893, when the firm had only 400 employees. The progress which had been made was largely due to the leadership and enterprise of Lord Weir. The presentation on behalf of the employees was made by the secretary, Mr. J. D. Imrie, and Mr. J. Pollok, the convener of the Shop Stewards' Committee, also spoke. A vote of thanks to Sir John Richmond was moved by the Hon. Kenneth Weir.

A Railway Mission to the Argentine

WITH the object of reviewing all questions relating to the operation and management of British railways in the Argentine, it has been decided to send to Buenos Aires a mission of three of the principal directors of the respective railway undertakings, which will leave this country for the Argentine probably some time next month. The matters to be discussed will, we understand, include such questions as railway extensions, tariffs, and the competition with road transport undertakings in the Argentine. The members of the mission are Lord Forres, who is a director of Balfour, Williamson and Co., Ltd., and a director of the Buenos Ayres Western Railway, Ltd., the Buenos Ayres and Pacific Railway Company, Ltd., and the Central Argentine Railway, Ltd.; Mr. J. M. Eddy, who is the chairman of the Buenos Ayres Great Southern Railway Company, Ltd., and the Buenos Ayres Western Railway, Ltd., and a director of the Buenos Ayres and Pacific Railway Company, Ltd., and the Central Argentine Railway, Ltd.; and Mr. H. C. Drayton, who is a director of the Buenos Ayres and Pacific Railway Company, Ltd., the Central Argentine Railway, Ltd., and the Buenos Ayres Great Southern Railway Company, Ltd.

Suggested Mersey-Humber Canal

IN an address to the Manchester Geographical Society, on Saturday, September 11th, Mr. Ellis Smith enlarged upon his recent suggestion that the Manchester Ship Canal should be extended to link up with the Humber. He felt that a canal cut across England, through the heart of its main industrial belt, would help to make this country greater than ever before and would enable it to maintain in peacetime that dynamic democracy which had been created during the war. A post-war project of this nature would be the means of revitalising the country's economic bloodstream, for it would reduce food transport costs, provide a speedy handling of goods, and assist in giving to Britain a larger share of the world trade by quicker access to ocean routes. The canal he had in mind, running through an important industrial part of England, would do much towards reviving what were formerly distressed areas, would stimulate new industries, and would create new inland ports. Mr. Ellis Smith claimed that the difficulties of constructing this Atlantic to North Sea canal would, when present-day engineering progress was considered, be nothing compared with the difficulties which confronted the builders of the Manchester Ship Canal at the end of last century. If the suggested canal ran from Manchester, through Penistone, Pontefract, or Doncaster on to Goole and Hull, it might help a great deal towards providing a solution to the serious river flooding problems of the Don Valley.

Research in the Mining Industry

ON Friday, September 10th, it was announced by the Mining Association of Great Britain that the colliery owners of Great Britain will provide further sums, of the order of half a million pounds, for coal research, in order to extend their existing programme, which itself involves the expenditure of £1,000,000 over the current five years. It will be recalled that the Parliamentary and Scientific Committee recently urged a great expansion of utilisation research into coal derivatives, adding that, although the work should be generously subsidised by the Government, it should be carried out by industry itself. The Mining Association subsequently announced that a further extension of the industry's coal research activities was contemplated and this provisional decision has now been formally ratified by the industry. The new programme relates to the development of processes for producing hydro-carbons and hydro-carbon derivatives from coal (a subject that was specifically mentioned in the recent debate in the House of Lords on industrial research) and, indeed, to the treatment of coal generally as a chemical raw material. The new programme will be begun immediately, and the colliery owners will themselves contribute between £400,000 and £500,000 towards its cost during the period ending with 1945.

The Late Mr. C. O. Grimshaw

MR. CONWAY OSBORNE GRIMSHAW, who died at Chobham on August 27th, at the age of eighty-one, was the eldest son of O'Donnell Grimshaw, of Merton Hall, Belfast. He received his early engineering training as a pupil with Combe, Barbour and Combe, of Belfast, and later in America with the Brown, Sharp and Betts Machine Company. In 1885 he joined the staff of Crompton and Co., of Chelmsford, and was employed as resident engineer on several electrical contracts. He was sent to India and Burma by Cromptons in 1888 to act for the Orient Electric Lighting Company and to report on establishing lighting stations in India, &c. In 1890 he was appointed resident engineer to the Eccleston Place station of the Westminster Electric Supply Corporation, and in 1897 he became assistant engineer-in-chief under Dr. A. B. W. Kennedy, which position he held until his retirement in 1926. From 1899 to 1902 he was responsible, under Sir A. B. W. Kennedy, for changing over the original system of D.C. steam generation at the three stations of the Westminster Electric Supply Corporation—Eccleston Place, Davies Street, and Millbank—to motor generator stations. This was concurrent with the building of the Central Electric Supply Corporation's generating station at Grove Road and, together with the sub-stations, formed one of the earliest three-phase, A.C. systems at 6600 volts. Mr. Grimshaw was appointed at this time, in addition to his other duties, deputy chief engineer to the Central Electric Supply Corporation. During the war of 1914–18, in addition to his other duties, he held a post under the Ministry of Munitions, directing the production of munitions in a large number of small factories in South-West London. He was elected a corporate member of the Institution of Civil Engineers in 1898, and became a full member in 1905.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. XI—*(Continued from page 202, September 10th)*

Water Supply and Hydro-Electric Power

A REMARKABLE phenomenon of the Australian Commonwealth is the group of artesian water areas. More than 8750 artesian and sub-artesian wells have been sunk to tap these underground supplies, the depth at which water is struck ranging from 10ft. to 7009ft. The daily flow of water from these bores is more than 340,544,000 gallons. Individual bores have a flow up to 1,750,000 gallons a day, the water being forced up in a gushing stream to the surface. In the "sub-artesian wells" the water does not come right up to the surface. Windmills, &c., are installed to pump it into storage tanks. The temperature at which artesian water reaches the surface varies from 60 deg. to 212 deg. Fah., and the quality is generally good. The sub-artesian water is mostly brackish and suitable only for stock watering. The great Australian artesian basin towards the west lies under about 600,000 square miles, or more than a fifth of the continent. There are five other basins scattered over the continent.

There are a large number of what are termed "shallow bores." The settler selects the site; the Government supplies plant, materials, and labour; the cost is repaid by the settler on terms. The New South Wales Government has equipped thirteen oil-driven boring plants which are transported from site to site, fuel and water being supplied by the Government. The average charge to applicants is about 15s. per foot. In New South Wales the total area of the districts where artesian wells are available is about 5,000,000 acres.

The Coolgardie Water Supply Works

The arrangements made to supply the great inland goldfields of Coolgardie involve the pumping of water a distance of nearly 350 miles from the west coast to this inland centre. This is probably the most remarkable scheme that has ever been devised for supplying an almost rainless area with fresh water. It was carried out by the Public Works Department of Western Australia.

The goldfields, whose centre is now Kalgoorlie, are situated on an elevated tableland about 1300ft. above sea level. The plateau has an average rainfall of 9in., but the record has been as low as 3½in. in one year.

The discovery of gold in this district was made in 1892. For some time the miners in this almost waterless country were dependent on a few "sand-soaks" and rock holes, which were generally carefully hidden by the aboriginals. The great inflow of population resulted in mining camps and small townships springing up, and it soon became obvious that an adequate supply of good quality water could not be provided locally. The problem of finding a supply of fresh water was first considered in 1895. The source of supply is situated about 28 miles from Perth, in the Darling ranges. The site of the impounding reservoir is at Mundaring on the Helena River. It has a catchment area of 569 square miles, and the whole of the watershed is thickly timbered. The average rainfall on the catchment area is 30in., and the annual inflow into the reservoir has varied from 300 to 41,000 million gallons. The reservoir has a capacity of 4650 million gallons, with a surface area of 672 acres.

The greatest depth of the water is 100ft. at the wall of the weir, which is 755ft. long. The work of construction was commenced in 1898 and completed five years later.

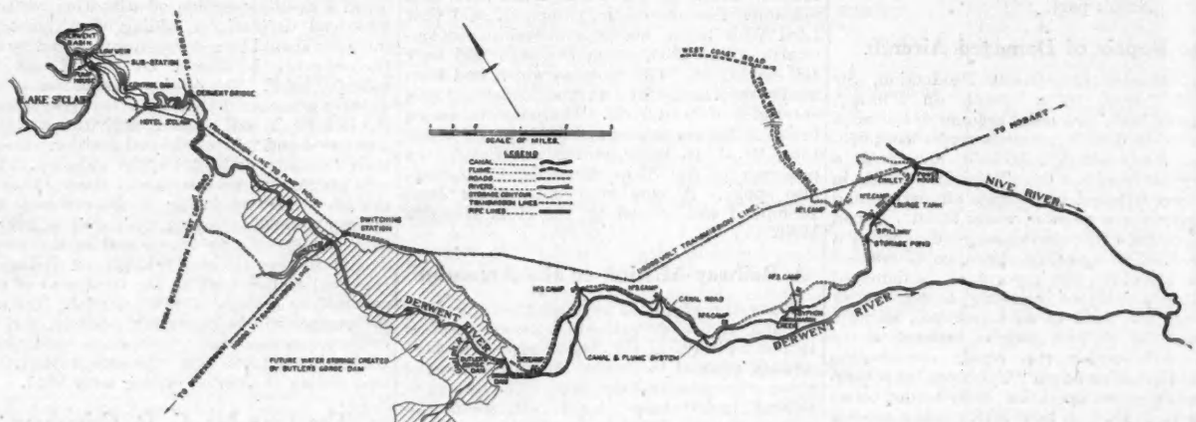
When the water leaves the reservoir it is pumped in stages to Kalgoorlie, there being eight pumping stations. After reaching No. 1 pumping station it is lifted 410ft., into a concrete tank of 500,000 gallons capacity at the second pumping station, which is distant 1½ miles. That second station lifts the water another 370ft. into a concrete tank of 1,000,000 gallons capacity, and from there it gravitates to No. 3 station, where the water is lifted 290ft. into a 1,000,000-gallon tank at No. 4 station. At this latter station it is lifted 396ft. into two receiving tanks, each of which holds 1,000,000 gallons. At this, No. 5, station the water is lifted 161ft. into a tank of 1,000,000 gallons capacity; and at No. 6 station the lift is 187ft. into a tank of 1,000,000 gallons capacity. At the next station it is lifted 179ft. into a tank of 1,250,000 gallons capacity, and from this station it gravitates to the last, No. 8, station into a concrete tank of 2,000,000 gallons capacity. The total length of the main conduit is 349 miles, of which 345½ miles is 30in. diameter and 3½ miles of 24in. diameter pipes. There is a standby reservoir for 10,000,000 gallons at No. 3 station, and another of 12,000,000 gallons near Kalgoorlie. This water supplies not only the mining districts, but agricultural land, and thirty towns along the route. The total length of main and reticulation pipes, including the main conduit, is 1369 miles. Branches supplying agricultural lands total 558 miles.

The engines at all the pumping stations are horizontal high-duty, triple-expansion, condensing, direct-acting, duplex Worthington pumping engines of 350 I.H.P. Each set of engines has a safety attachment which automatically stops the engine if the pressure in the main rises above or falls below the desired limits. The engines, pumps, boilers, economisers etc., installed in all pumping stations were made in Britain.

The first water was pumped from No. 1 pumping station in March, 1902, and reached Kalgoorlie in January, 1903, but under usual working conditions the water takes one month for the long journey.

For the greater part of the length the main is laid in a trench, but when it had to cross a salt lake the pipes were supported above the ground by piers. There was a good deal of trouble at first with both external and internal corrosion, and in 1917 a deaerator was installed at No. 1 pumping station. This extracts about 90 per cent. of the dissolved oxygen and the corrosive effect is diminished in the same proportion. Later, the 10 per cent. of residual oxygen is removed during the passage of the water through about 30 miles of main, and after that arrangement there was no corrosion on the steel test pieces immersed in the pipes.

The cost of the whole scheme up to the end of June, 1925, totalled £3,554,274, and there was a deposit of nearly £50,000 per annum when the working expenses, interest charges, and sinking fund contributions were paid. It was a bold scheme, carefully planned and carried out under very difficult conditions.



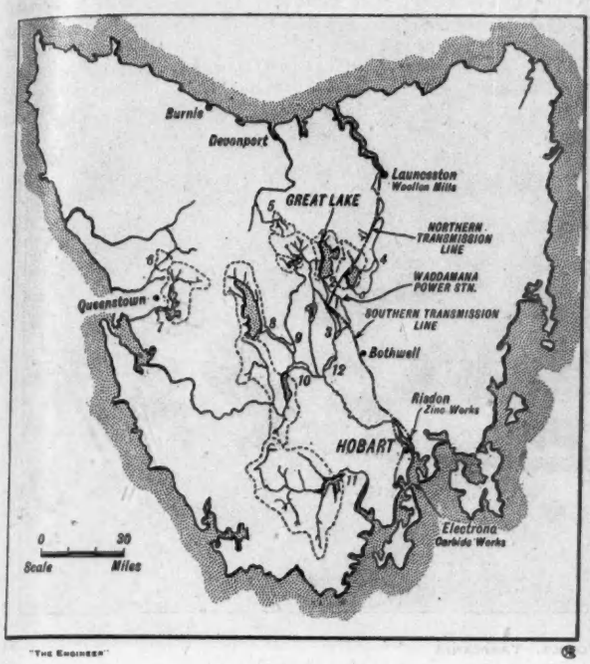
TARRALEAH POWER DEVELOPMENT

The Kilwa Hydro-Electric Scheme

In the heart of the Australian Alps lie the Bogory High Plains, a plateau some 5500ft. above sea level. The State Government of Victoria has adopted what is called the Kilwa scheme. It will utilise to advantage the natural conditions of the country for the generation of electricity. The total installed capacity of the plant is to be 117,000 kW.

The East Kilwa River takes its course in a

snow-clad region where there are three elements that favour water power development. They are (1) rainfall (and snow) exceeding 80in. per annum, (2) suitable storage at a high altitude, (3) a high head of



MAP OF TASMANIA

about 4000ft., which will be utilised in four stages, two of about 1500ft. each, the others 300ft. and 640ft. respectively.

The main storage reservoir, at Pretty Valley, will have a water surface of about 3 square miles and a capacity of 95,000 acre-feet. The second storage in Rocky Valley will have a capacity of 13,000 acre-feet. These will maintain sufficient water to operate all the plant under a most severe drought.

A remarkable feature of the scheme is the extent to which tunnels are used to convey the water. Mr. A. G. M. Michell investigated the possibilities of power production in this district (1919), and since 1923 the engineering staff of the Government has been at work on it, carrying out river gauging, drilling, and geological investigations, together with designs and estimates. In 1939 the first 10 miles of the 25 miles of road now finished was begun.

Tunnelling work was commenced (1940) through very broken and granulite country. Electric power was supplied at 22,000 volts, reduced to 400 volts for construction work, lighting, ventilation, air compressors, and workshops from the State supply.

A site for main camps for some 400 men, graded roads, some thirty dwellings for married employees, sewerage and other amenities were provided in a position central for the scheme.

From the reservoir the water is conveyed by tunnels through the solid granite rock of the mountains to where a steep fall of 1500ft. at No. 1 power station takes it down a steel pressure pipe to turbines of 21,000-kW output. The elevation then is 3700ft. Additional catchment areas increase the flow to the next stage, where it passes along an open channel and then it goes through a tunnel to No. 2 power station, where, with a head of 1500ft., some 33,000 kW will be generated. At that point water has flowed for some 7 miles from storage on the plateau.

After discharging from No. 2 station the waters are again supplemented by flow from other streams, and run into a 1300-acre-feet reservoir, created by building a concrete slab and buttress dam about 80ft. high across a narrow rock-bound outlet. It then flows through a rock tunnel for a distance of 4389ft. on a level gradient, thence it runs down another unlined tunnel, 330ft. long, inclined at 49 deg. to the horizontal. Then the water flows practically horizontally for 677ft. to No. 3 power station. The main tunnel is 15ft. by 15ft. 6in., and the remainder 13ft. 6in. in diameter. In No. 3 station a head of 360ft. will generate 24,000 kW.

Water from the West Kilwa provides additional energy for stations No. 3 and No. 4. This water is carried through a tunnel 4 miles long. After No. 3 station another rock tunnel, 11,500ft. long and 15ft. by 15ft. 6in., carries it to the final drop of 640ft. at No. 4 station to turbines of 39,000-kW capacity. The discharge of 960 cusecs passes through a tunnel 6500ft. long and a tail-race 4300ft. long to storage on flats adjoining the West Kilwa River. Over 4000ft. of wide tunnelling was necessary to ensure the required flow of water.

At Nymboida, in the north-east section of New South Wales, a hydro-electric plant has been established, and town and rural populations within an area of some 6000 miles are served mainly from this source.

HYDRO-ELECTRIC POWER IN TASMANIA

A general impression that the Dominion is a comparatively riverless, lakeless country, and that therefore there is very little water power available is true for most of the continent, although not altogether true for the eastern States of the mainland, and it is certainly quite untrue for the Island of Tasmania, which has a very plentiful supply of water power.

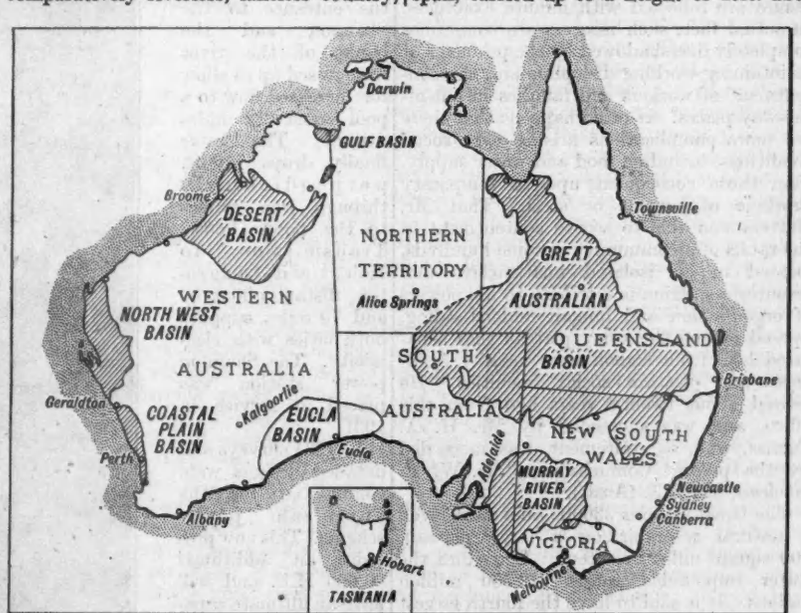
The total potential water power of the Dominion has been estimated at 4,750,000 H.P., of which 3,500,000 H.P. (74 per cent.) is located in Tasmania. Of the balance available on the mainland, about two-thirds, or some 830,000 H.P., is located in an area of about 100 miles radius from the Australian Alps. Of the water power developed, Tasmania is listed (in 1940) with 143,000 H.P. The first scheme to be developed in that State is known as the Great Lake Project, the power station is named Waddamana.

The Tasmanian Great Lake hydro-electric scheme was commenced (1909) to supply power for metallurgical purposes. The private concern that initiated the enterprise transferred its rights and plant, &c., owing to financial stringency due to the war, on reasonable terms to the Tasmanian Government (1914). A contract was made to supply power up to 30,000 H.P. at £2 per horsepower per annum to the Electrolytic Zinc Corporation (1917), which owns, near Hobart, the largest electrolytic zinc works in existence. The first installation of 10,000 H.P. came into operation in 1916; the power used is now 45,000 H.P. The State also supplies 5500 H.P. power to a concern that manufactures carbide on a large scale; Great Lake power also supplies Hobart and Launceston with power for factories, &c., and practically every town of importance in Tasmania has electric supply.

The Great Lake plateau towers centrally above the linked centres of population and industry. It slopes down to form a natural basin, 17 miles long and about 41 square miles in area. This natural reservoir narrows down to the outlet, the Shannon River. Thence it falls through a winding course to the level 1350ft. below the Great Lake.

The impoundage of the Great Lake was done by means of a concrete multiple arch dam, which at the time of its construction was the longest dam of its type in the world. There are twenty-seven arches, each of 40ft. span, carried up to a height of 40ft. above sill level. The area of the lake was increased to 58 square miles at 35ft. above sill level, the capacity being 1,150,000 acre-feet.

Mr. John Butters, an engineer of dynamic energy and professional ability, was chief



ARTESIAN WATER SOURCES OF AUSTRALIA

engineer of the metallurgical company that initiated the first scheme for water power development, and his services were retained by the Government when it took over the energy of the River Derwent running out of Lake St. Clair. All three schemes are under the control of the Government Hydro-Electric Commission. There are other small schemes which may be developed into important supply stations.

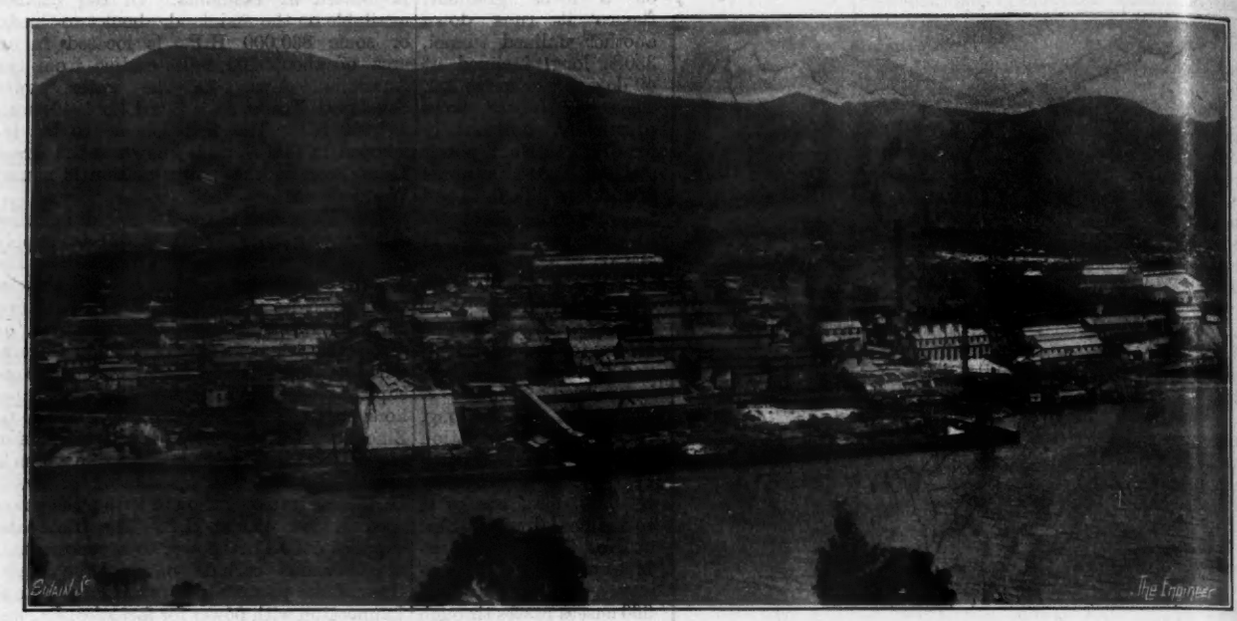
Two rivers that supply the two power schemes first mentioned above are named the Ouse and the Shannon. The Ouse rises well above the lake, and although in its natural course it joined the Shannon some distance below, a diversion channel has brought the river into the lake.

Dams were built at the entrance to the Shannon and the banks of the river were raised up to allow for increased flow to a pool some 12 miles distant. The water finally drops 1100ft. perpendicularly through iron flumes to the power house. Transmission to Hobart and Launceston, distant about 50 and 70 miles, supplies both cities with electricity. The Shannon power station was placed in service in 1931.

In 1934 surveys and detailed designs were commenced for the Tarraleah power scheme. This now provides an additional 63,000 H.P. and will have an ultimate capacity of 105,000 H.P.

A dam was built across the River Derwent in order to control the flow and a pumping plant was installed to maintain the flow of water in the river whenever the level of the lake falls below the outlet of the discharge flume. A weir at the outlet from the lake prevents pump water from running back into the lake when the level of the latter is low.

There is a natural channel of the river for 15 miles to the intake works, where a massive weir and spillway have been built to divert the water into the canal and flume system, about 12 miles long, which terminates in a storage basin. At a point 9 miles below the intake works a deep gorge had to be negotiated by the construction of an inverted siphon, an integral part of the canal system. The power-house is situated at the bottom of



ELECTROLYTIC ZINC WORKS, TASMANIA

WADDAMANA POWER STATION, TASMANIA

enterprise. Not the least easy of his problems was the arrangement for the transport of heavy machinery and other supplies to the difficult country around the Great Lake. His work, which included rousing enthusiasm for power development, was subsequently recognised by the honour of knighthood bestowed by the King.

The general public has a popular idea that the duties of an engineer consist merely in drawing out bewildering plans on paper and directing involved construction, based upon mathematical calculations, which he must ensure are followed with minute exactness. In actual fact, such matters are sometimes completely overshadowed by the problems of maintaining working discipline and the contentment of workers and families in out-of-the-way places. It often happens that there are more complications arising over social conditions, including food and water supply, than those consequent upon a temporary shortage of cement or steel. That Mr. Butters was able to secure contentment in the ranks of a community of some hundreds, located in an isolated unattractive and resourceless region is a tribute to his powers of organisation and human understanding. Spread out on the stony plateau that separated lake from lagoon were healthy residences and pleasant social amenities. He retired about twenty years ago from this office, and was succeeded by Mr. H. A. Curtiss, who, on retirement, was succeeded by the present Commissioner, Mr. W. E. Maclean, M.I.E.E. (Aust.).

The Great Lake is 3300ft. above sea level, a natural reservoir on a large plateau, 200 square miles in extent. When full the water impounded totals 312,500 million gallons. It is said to have the fourth largest storage capacity in the world.

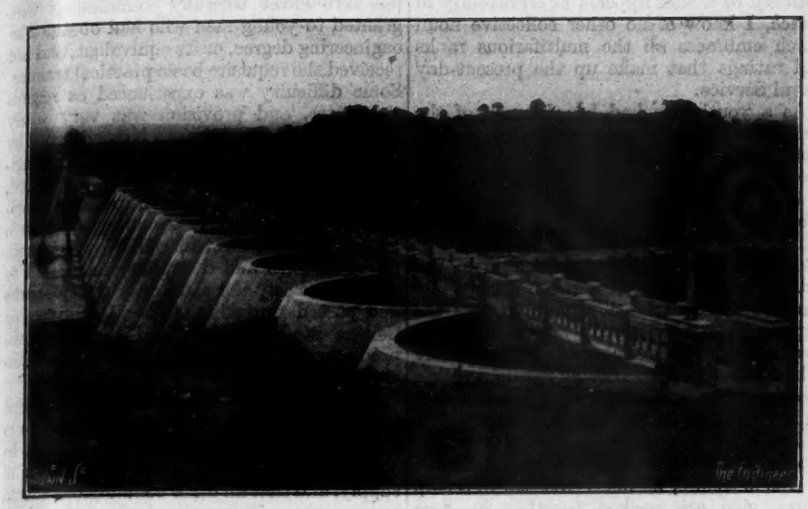
There are three main power stations in Tasmania :—(1) The Waddamana, which develops about 66,000 H.P.; (2) a supplementary station a few miles higher up on the Shannon River, developing 14,500 H.P.; and (3) the Tarralean power station, with installed capacity 63,000 H.P., which utilises the

a gorge some distance from the storage basin.

Since the original plant in Tasmania was started up in 1916, the demand for power in Tasmania has been phenomenal. A year later the maximum demand was 2820 H.P., and in 1942 it was 139,000 H.P. Works are under construction and plant ordered in England to meet anticipated demand. During the period 1916–37 the circuit mileage of the 110,000 and 88,000-volt main transmission lines increased from about 62 to 527 miles, and the lower-voltage lines (44,000 to 2200 volts) from 20 to 910 miles. For bulk supplies the rates are from £10 per annum per horsepower of maximum demand between 500 H.P. and 1000 H.P., graded down to £4 per annum per horsepower for supply between 7500 H.P. and 15,000 H.P.

In addition to the load provided by the metallurgical and carbide industries, power is consumed by firms attracted by cheap power, and the ideal climatic conditions, from other parts of the Empire. Cadbury-Fry-Pascall, Ltd., have a splendid antipodean counterpart of the famous Bournville village. At Launceston the great English industrial firm of Patons and Baldwin, Ltd., manufacturers of high-grade knitting wool, have established a factory. At Railton are the works of the Goliath Portland Cement Company, Ltd. Kelsall and Kemp, Ltd., were also attracted to Tasmania, where they have established a factory to supply woollen goods to the Australian market. Another firm has used power to revolutionise the cooling and canning processes for its products. Successful experiments with Tasmanian wood for the making of paper pulp have been carried out, and it is believed that Tasmania will enable Australia to retain the millions spent overseas for newsprint. This industry is now successfully in operation on a large scale. Tasmania has a great asset in its present and potential hydro-electric supply systems.

(To be continued)



MULTIPLE ARCH DAM, GREAT LAKE, TASMANIA

Experience Teaches*

By Engineer Vice-Admiral Sir GEORGE PREECE, K.C.B.

WHEN considering the admittedly difficult problem of preparing a presidential address, two possible courses present themselves to the ordinary individual. He can delve into the records of past achievements and of past failures and, if he be wise enough, from these point a moral and adorn a tale. Alternatively he can review those events of which he is personally cognisant and, while his own experiences must in general be extremely limited, it will be odd if amongst them there are not at least one or two that seem to him to be somewhat unusual and therefore possibly worth placing on record, if only to save those who learn of them the necessity of worrying out for themselves the causes of the phenomena observed should they, or something like them, occur again. In some cases it is to be hoped that it may serve to prevent a recurrence of such incidents.

During the period of forty-odd years which has filled the storehouse of my mind with memories, changes have taken place which can literally be described as revolutionary. When I first went to sea there was no prime mover in the ship that was not a reciprocating one, but all this was gradually changed until a stage was reached when, in some ships at least, there were none—the engines had all become rotary ones. In the intermediate stages a mixture of the two types was in vogue, which led a newly fledged and somewhat facetious young officer to write with obvious mock self-pity to a friend that the ship was full of engines, some of which went up and down very slowly whilst others went round and round very fast, and it was all very confusing. The mention of reciprocating engines brings to mind a foggy early morning following an equally foggy night and the engineer officer of the watch, just relieved, meeting the upper deck officer of the watch, who had also just left the bridge. The usual brief greetings were exchanged, and it transpired that the bridge had had a very poor night indeed, as they had been worried by the sound of a mysterious fog horn that appeared to be sounding intermittently and dead ahead. No matter how the course was altered to avoid the vessel that was supposed to be emitting it, the result was a complete failure, the sound persisted in remaining always right ahead. In the light of his inside knowledge the engineer officer said that he would go on to the bridge and see if he could elucidate this strange phenomenon. After waiting some time the noise was heard again, but the engineer officer has never been quite certain whether he was popular or the reverse when he explained that the supposed fog horn was, in fact, the noise of a feed pump in the forward boiler-room, which had that night developed a habit of groaning at odd and quite irregular intervals. The necessity for closer co-operation and a more complete interchange of information between bridge and engine-room than is usual was thus early borne in on him.

A matter which has always been a problem to me, as I expect it has to most engineers, is the correct relation of theory and practice—how much value to place on one and how much on the other. In spite of, or perhaps because of, my having had so much to do with theory, I have always had a perhaps unjustifiably exaggerated respect for practical experience. I can well recall my first full-power trial, during which the starboard high-pressure engine developed a hot crank-head, crosshead, and guide, and things looked serious. It was producing more power than its associated intermediate-pressure engine, and theory indicated the desirability of using the independent linking-up gear on this latter engine. The result was most satisfactory, for in less than half an hour the high-pressure engine was running quite cool; but I can still recall my astonishment that theory should have worked quite so well as it did, although I need hardly say that I did not allow any of this surprise to show.

Conversely, I recall another incident where theory did not appear to work so well, and that was when I observed the worm wheel of the cable holder overhaul its associated worm, although theory indicated that the device should be irreversible and self-holding. Admittedly the conditions were abnormal and the pull on the cable excessive, and subsequently it was discovered that the bed-plate had cracked across in the region of maximum bending moment. I have since thought that teachers and students are perhaps somewhat prone to focus their attention on the stresses and strains of the moving parts of machines and too apt to forget the corresponding reactions on the framework, possibly because this latter part is pictured as being comfortably bolted to something that is supposed to be solid and immovable. It is very probable that this thought, combined with others not so refined, came into my mind as we toiled at the job of lifting the machine from its seating in the ship and of placing a thick steel plate under the original bed-plate. Accurately fitted bolts were used throughout, and theory, or it may have been plain common sense, dictated a shape for the plate that was best suited to meet the stresses that it had to withstand.

These and similar incidents direct my thoughts to a state of mind which is sometimes produced in the young engineer when he first goes to sea by his unfamiliarity with his surroundings. His brain is possibly chock-full of information as to what operations ought to be carried out in connection with the machinery in his charge; but, being unfamiliar with ship routine, he will not know either exactly at what time they should take place or whose job it is, either individually or collectively, to carry them out. A good motto to adopt in such cases is "Wait and see," but do not do either at all obviously. Routine is routine, and someone or other will sooner or later report that such and such an operation is ready to be executed. The

* Presidential Address to the Institute of Marine Engineers, Tuesday, September 14th.

embryo officer will be well advised to appear intelligent, say "Carry on," and then look intelligently at what happens. Speaking for myself, although I had been taught at schools and colleges for the best part of twenty years, I feel that I acquired information during my first year at sea at a far greater rate than during any similar period before.

I imagine that it happens to few engineers, sea-going or otherwise, to receive an urgent summons to come at once because the feed tank is on fire. The message was, as you will no doubt suspect, not precisely accurate, as what was actually taking place was that the main air pump breathing pipe was emitting flames which rose and fell with each stroke of the pump, whilst just before the messenger had been dispatched there had occurred a quite violent explosion in the engine-room ventilation downtake, the top of which formed a fair-sized pocket, accompanied by a considerable irruption of flame into the engine-room. Knowing the elusive, or should one say diffusive, properties of hydrogen, it will, I think, be a matter of surprise to many to learn that an overheated boiler had produced this gas in sufficient quantity to form with air an explosive mixture after it had passed through the engines and condenser and made its exit *viâ* the breathing pipe. The manner in which it was ignited was also not without interest. The chief engine-room artificer on watch, looking up into the engine-room casing into which the air pump breathing pipe was led, observed what he took to be the commutator of the ventilation fan sparking badly, and he went up to attend to it. He remembered nothing of what had happened when he regained consciousness; but I think there can be little doubt that what he saw was the gauze cover over the commutator acting as it does in a minder's safety lamp, and unfortunately when he removed the cover he opened the lamp.

There is, indeed, a strangeness in the very atmosphere of ships for which one is not prepared, which is well illustrated by the following incident. On returning from one of the innumerable "sweeps" of the North Sea it was necessary to examine one of the turbine main regulating valves. Time was short and the matter was urgent, and so main steam was shut down in the shortest possible time. Access was conveniently provided through an examination door on the front of the valve. All went well for a little while, when suddenly there was a very unpleasant rush of steam from the opening. The most complete steps were taken to isolate that section, but without avail, for at odd intervals the valve put up a very good imitation of a small geyser. When two people had been scalded, fortunately only slightly, the rest just sat down and thought hard. It is doubtful if the mystery would ever have been solved if it had not been noticed that the gush of steam was always accompanied by a dull and apparently distant thud. Investigation showed that the thud was produced by the closing of one of the doors giving access to the engine-room *viâ* the casing in which the ventilating fans were situated. The explanation of this strange affair then became immediately apparent. Exhaust fans were running at the time, and although one did not realise it, the pressure in the engine-room was normally slightly subatmospheric. When the door was opened it rose to something more nearly atmospheric and air entered the turbines, which were large and very hot. When the door banged shut the pressure suddenly dropped again and this air, heavily charged with steam, was drawn out again into the engine-room. I think it is fair to assume that had this not been observed before the turbines had had time to cool down, the cause of this odd phenomenon would never have been discovered and it would have taken its place amongst the other unsolved mysteries that have baffled those who go down to the sea in ships.

Having described some of the more curious experiences connected with material things, I should like to devote some little attention to matters concerning naval engineering personnel. I use the word "personnel" deliberately, since, despite the adverse criticism of it that appears intermittently in *Punch*, I know of no other collective noun which embraces all the multifarious ranks and ratings that make up the present-day Naval Service.

As a youth one had heard much of the strictness of naval discipline, but in actual fact this discipline is nothing but the machinery whereby each individual is made to show consideration for the remainder of the community in which he happens to be living. Much has been said and written of late on the subject of the freedom of the individual and much of it has unfortunately been worded in such a way as to give the impression that everybody was to be free to do exactly as he or she pleased. More recently it has been qualified as being freedom within the law of the land, but surely it is a fact that an individual can be an unmitigated nuisance to his neighbours whilst still keeping within the law. Consideration for others, desirable as this is ashore, becomes essential in a ship where men are packed together in close proximity for long periods at a time and with no possibility of getting away from sources of annoyance and irritation.

It was accordingly very refreshing to read in the Government's White Paper on Educational Reconstruction, recently issued, that arrangements are envisaged "which will enable young people to obtain the experience of community life, self-government, and individual self-discipline which are the foundations of democratic citizenship."

Very significant also are the words of the Parliamentary Secretary to the Board of Education in replying for the Government in the debate on that White Paper when he remarked in connection with the many references made to public schools: "One of the most astonishing things in recent months has been the steady drift of working-class opinion, and by that I do not mean merely the manual workers, but what we call the parents of the general elemenatary school population, towards the idea that a residential education for some part of a child's school career is a thing infinitely worth while."

It appears that people are beginning, at long last, to realise that human beings are not in general endowed at birth with those qualities of self-discipline and consideration for others that are necessary to make community life tolerable, and that the sooner they are taught to acquire them the better for all concerned.

My impression therefore of naval discipline is that, like the old age of Shakespeare's gardener Adam, it is "frosty but kindly," and in its general effects more kindly than frosty.

One of the most difficult problems, for which a solution must be found, is the provision of professional engineers and technicians to meet the demands of the greatly expanded Navy required in time of war. Starting with the raw material, it is not a matter of months, but of years, that is required to produce the finished article, and it is therefore of little use to commence the training of large numbers when the war starts, for, even when these become available for sea service, they will still lack that experience which time alone can bring.

In the past, so far as officers were concerned, the engineers of the Royal Naval Reserve were regarded as the main source of supply, but under modern conditions of war the expansion of the Merchant Navy brings just as many problems to it as to the other national Services, and so a solution must be sought in other directions. A move in the right direction was made just prior to the outbreak of this war when a new scheme was put into effect whereby commissions were granted to young men who had obtained an engineering degree, or its equivalent, and had received the requisite basic practical training. Some difficulty was experienced as regards the latter, and provision was very wisely made for this deficiency to be made good by placing the young officers with marine engineering firms for a greater or less period, depending on the extent of the practical training they had received previously. After a further short course to familiarise them with naval customs and discipline, they went to sea in precisely the same way as those who had passed through the Naval Engineering College at Devonport, and thereafter the products of the two systems should be indistinguishable from each other.

In the early days of the war it was decided that the permanent complement of officers required for the post-war fleet should be obtained through the normal channels of supply, and that all other commissions should be temporary. Thereafter those young officers who were recruited when fully trained in the shore sense were given temporary commissions as Royal Naval Volunteer Reserve officers; but after they have received the appropriate naval training and have qualified they are given temporary Royal Naval commissions and wear ordinary naval uniform.

It is to be hoped that when the war is over there will be room in the Navy for those who wish to make it their life's work, whilst there is no doubt that those who return to shore life will be all the better for their experience in the operation of naval machinery and of the control of other officers and ratings. They will naturally form a magnificent reserve who can be called upon in the event of future trouble, but they will grow older and it is young men who are needed in great quantity in modern war.

Before we leave them, it is interesting to observe that if the only consideration were preparedness for war, these men should, until they become too old for service, go into branches of engineering that are not essential to the war effort, so that their recall would produce the minimum effect on war production. The same procedure should logically be applied to all reservists and pensioners who are liable to be recalled to the Colours. The objection to this is that the experience which they have gained in the operation and maintenance of naval machinery of all kinds would not be made available to the firms that design and produce it.

There does not appear to be a complete solution to this problem; but, at any rate, when new schemes are projected, it should be remembered that engineers are just as necessary to produce armaments as to use them. For instance, it seems to have been somewhat short-sighted to have recruited a Territorial Army from, amongst others, the employees of many of those engineering firms that would obviously be required to increase their output on the outbreak of war. That the highly experienced executives of these firms should have been specially encouraged to join, so as to give a lead to the other employees, seems to show an even greater

lack of vision. Perhaps the most difficult problem of all is to overcome the innate preference of man to use weapons rather than make them.

As to the future, it is most profoundly to be hoped that the pre-war practice of giving permanent commissions to a certain number of suitably qualified candidates will continue. Not only is it good of itself to recruit from as many sources as is reasonably practicable, but this particular scheme maintains contact between the Navy, industry, and the related centres of learning, thus providing a source of supply that could be expanded as circumstances required.

It may be remarked in passing that at present commissions are open to the Dartmouth and special entry cadet, the artificer apprentice, the engine-room and the ordnance artificer, and the warrant and the commissioned warrant officer. In addition to these sources of recruitment to the permanent ranks, it is most desirable that a large number of Royal Naval Volunteer Reserve engineer officers should be recruited. This body would be composed of engineers who are fully trained in their profession who would like in the event of war to serve as naval engineers, and who lack initially nothing but sea-going experience. It is to be hoped that opportunity would be provided for them to acquire this experience by serving in naval ships for the requisite period, either continuously or intermittently, in peacetime, so that they become fully qualified in the naval sense before the need for their services arises. There would in this way be provided a reservoir of officers which could be drawn upon immediately war broke out.

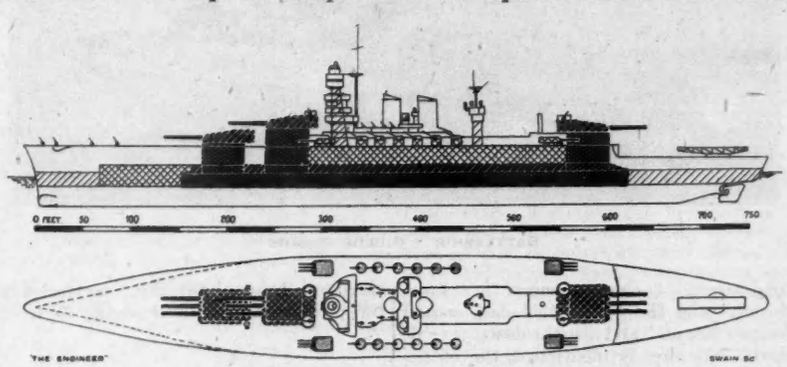
I have endeavoured in this address to give you a few examples of the problems that arise in the operation of machinery at sea, and an account of the almost more difficult problems associated with the provision of one section of the naval engineering personnel that is required to solve such problems. The earlier portion will, I hope, serve to stimulate further the interest of young men who feel the urge to serve their country in a sea-going capacity and the latter to indicate to them the way in which to give effect to their desire.

May I, in conclusion, say how greatly I, as a former naval officer, appreciate the honour of being the President of this Institute at a time like the present, when both Royal and Merchant Navies are joined together more closely than ever before in their efforts to restore to the sea, and consequently to the world, its bygone traditions of chivalry, decency, and consideration for others.

NEW BRITISH CHEMICAL STANDARDS. — The Bureau of Analysed Samples, Ltd., of Markington, Harrogate, announces that the following new analytically standardised steel is ready for issue :— B.C.S. manganese-molybdenum steel, No. 214 : Mn, 1·61— ; Mo, 0·255 ; C, 0·375 ; Si, 0·24— ; S, 0·033 ; P, 0·024 ; Cu, 0·24— ; Ni, 0·16— ; and Cr, 0·06— per cent. As usual, this steel has been analysed by a number of chemists representing independent analysts and several works chemists representing manufacturers of this type of steel. This composition comes within the chemical specification for steel B.S. En. 16-V 9 A, and will be found useful to chemists wishing to check the composition of steels made to this specification. In addition to the above, a replacement of nickel steel "T 2" has recently been made, viz., 3 per cent. nickel steel, No. 222 (Ni, 3·39 per cent.). The following new standards are in course of preparation :—Aluminium alloy, No. 216, containing approximately Cu, 4 ; Mn, 0·5 ; Zn, 0·2 ; Mg, 0·5 ; Ni, 0·2 ; and Ti, 0·1 per cent. Cr-Ni-Mo steel, No. 219, containing approximately Cr, 0·7 ; Ni, 3 ; and Mo, 0·6 per cent. High-speed tungsten-molybdenum steel, No. 220, containing approximately tungsten, 6 ; Cr, 4 ; V, 1·3 ; and Mo. 4·5 per cent.

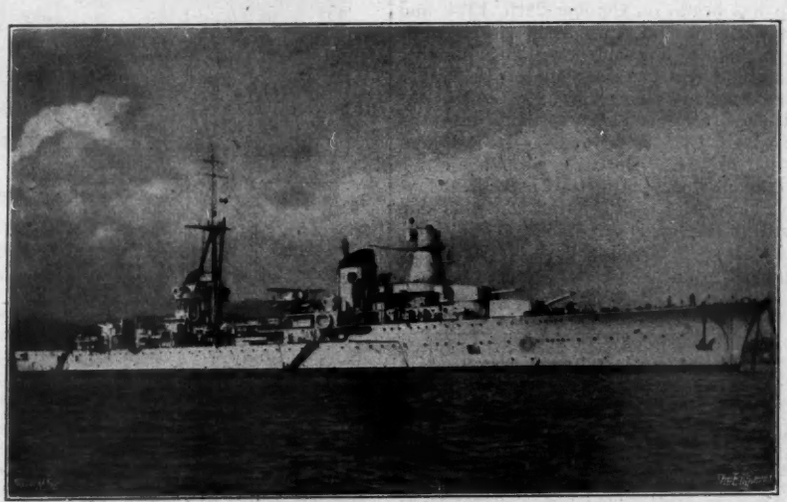
The Surrender of the Italian Fleet

ON Saturday evening, September 11th, Admiral of the Fleet Sir Andrew Cunningham, Commander-in-Chief Mediterranean, announced that a large part of the Italian fleet was anchored under the guns of Malta. It was on Friday afternoon that Sir Andrew, with his guests, General Eisenhower and high naval officers, stood on the compass platform of the "Hunt" class destroyer "Hambleton," and watched the arrival of the Italian ships from the port of Spezia, led by the "Warspite" and the "Valiant" and units of the British Eighth Destroyer Flotilla. On that voyage one of the capital ships, the battleship "Roma," one of the newest ships of the "Littorio" class, was sunk in the channel between Corsica and Sardinia by German bombing and torpedo-carrying aircraft. The ship was struck in the middle and exploded. Some of the crew were rescued by the other ships. Only one other ship was damaged, and that not very seriously. Allied air cover was later given to the convoy until it reached the protection of the British Navy. Later on, further battleships arrived from the port of Taranto, now in British hands, where they had surrendered to H.M.S. "King George." On Monday six more ships arrived, including the battleship "Giulio Cesare," which had steamed some 740 miles from Venice in order to comply with the Armistice conditions. In all, more than thirty-six ships of the Italian fleet are now safely in Malta, and more destroyers and submarines are arriving. It is known also that a small Italian naval unit has arrived in Cyprus, and that other ships put into Pollensa in the island of Majorca and, after landing wounded, left again for an unknown destination. Five other Italian warships, consisting of one cruiser with destroyers and gunboats, put into Port Mahon, and after overstaying their allotted twenty-four hours' permission, were interned by the Spanish authorities. Thus practically all the important units of the Italian fleet have been accounted for. Two of the larger ships, both in dockyard hands, still remain in Italian ports. They are the battleship "Impero," which is now nearing completion at one of the Ansaldo establishments and is probably in an advanced stage of fitting out, and the battleship "Conte di Cavour," which was badly damaged at Taranto in 1940 and is under reconstruction at Trieste.



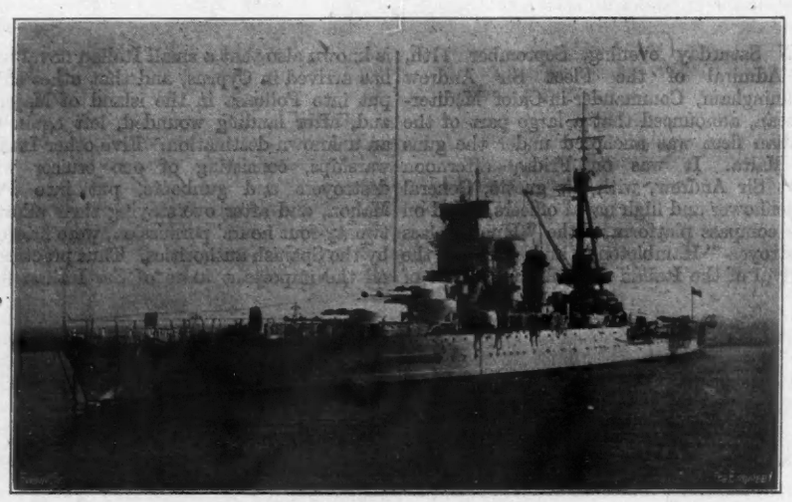
"LITTORIO" CLASS BATTLESHIP

Among the ships which arrived from Spezia were the "Littorio" class battleships "Italia" (ex-"Littorio") and the "Vittorio Veneto," along with the "Condottieri" class "E" type cruisers "Giuseppe Garibaldi," "Luigi di Savoia," "Duca Degli Abruzzi," and the "D" type cruiser "Emanuele Filberto Duca D'Aosta," with the "C" type cruiser "Raimondo Montecuccoli." The destroyers in this convoy of naval vessels have been officially announced as follows :—"Nicoloso da Recco," "Alfredo Oriani," "Velite," "Artiglieri," "Fusiliere," "Grecale," and "Legionale." Among the ships which arrived from Taranto were



CRUISER "RAIMONDO MONTECUCCOLI."

the "Cesare" class battleships "Caio Duilio" and "Andrea Doria," and the "Condottieri" class cruiser "Luigi Cadorna" and the "Regolo" class cruiser "Pompeo Magno," and also the destroyer "de Arreco." As already mentioned, the battleship "Giulio Cesare" arrived from Venice, and with her were the seaplane carrier "Giuseppe Miraglia," formerly the "Cita di Messina." Herewith we reproduce photographs of four of these battleships and cruisers.



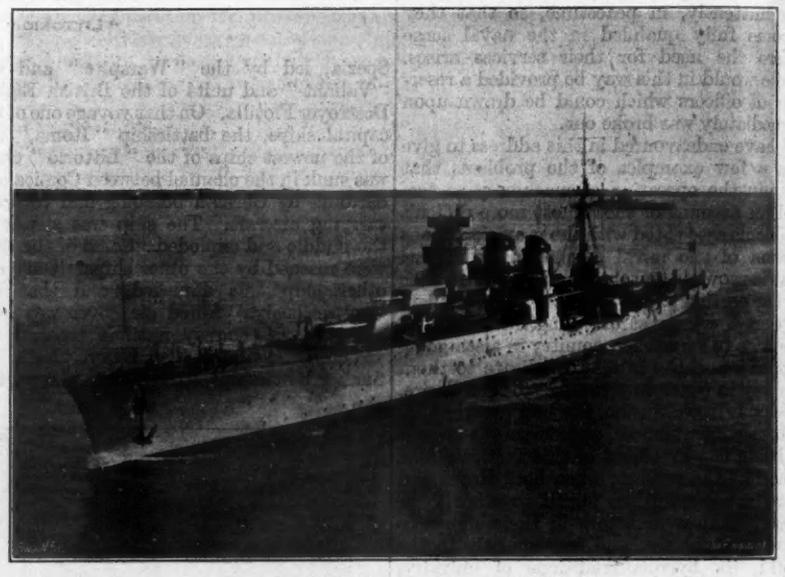
BATTLESHIP "GIULIO CESARE"

General Particulars of Construction

The battleships of the "Littorio" class are four in number. The name ship, the "Littorio," to which at a later date the name of "Italia" was given, was laid down in the Ansaldo yards on October 28th, 1934, and was completed on May 1st, 1940. She was followed by the "Vittorio Veneto" and the "Roma," which were built and engined at the San Marco yards of the Cantieri Reuniti Dell Adriatico at Trieste. The first ship was begun on October 28th, 1934, and was completed on April 30th, 1940; while the "Roma" was laid down on September 18th, 1938, and was completed in 1942. The "Impero," the construction of which was entrusted to Ansaldo, was laid down on May 14th, 1938, and was also due for completion in 1942. Actually, probably owing to damage due to Allied air attacks, delays took place, and it is believed that this ship is still in the fitting-out stage.

All these battleships have the following principal dimensions and particulars:—Length between perpendiculars, 754ft. 3in., on water line 762ft. 6in., and overall 775ft.; maximum beam, 106ft. 6in.; mean draught, 28ft.; and maximum draught, 30ft. 6in.; main armament, nine 15in. guns, twelve 6in. guns, twelve 3·5 A.A. guns, and forty A.A. machine guns. The armoured belt is stated to vary in thickness from 12in. to 9in. Three aircraft are carried and two sets of catapults for launching them are fitted.

The propelling machinery consists of a four-screw arrangement of Parsons geared turbines, which take steam from three-drum boilers designed to burn oil fuel. The designed output of the turbines is about 130,000 S.H.P., and during trials the designed speed of 30 knots was exceeded. The trials of the first two ships were begun in December, 1939, but it was not until four or five months later that they passed their acceptance tests and were handed over from the builders to the Italian Navy. The delivery dates for the "Roma" and the "Impero" were originally fixed for 1942, but doubtless owing to industrial disturbance attendant upon Allied bombing, their construction was slowed down and the completion delayed. The "Littorio" class was built to the designs of Engineer Inspector-General Umberto Pugliese. Both the "Littorio," now named the "Italia," and the "Vittoria Veneto" received considerable damage at Taranto and elsewhere from British torpedoes and bomber aircraft, and during recent months they spent much of their time under repair in Italian dockyards. The diagram of one of the battleships of the "Littorio" class, reproduced herewith, shows the general arrangement of the guns and armoured protection.



CRUISER "DUCA DEGLI ABBRUZZI"

"LITTORIO" CLASS BATTLESHIP AT SEA

We are indebted to Mr. Francis E. McMurtrie, A.I.N.A., the editor of "Jane's Fighting Ships," and to the publishers of that annual, Sampson Low, Marston and Co., of Essex Street, Strand, W.C.2, for the use of this drawing and for photographs of the battleships and cruisers, and some technical particulars.

The "Cesare" class of battleships, three in number, the "Giulio Cesare," the "Caio Duilio," and the "Andrea Doria," were originally built in 1912–15 at Ansaldo, Spezia, and Castellammare, and were fitted with Ansaldo engines. They were reconstructed in the years 1933–39. The standard displacement as reconstructed was 23,622 tons, or over 25,000 when fully loaded, a complement of 1198 officers and men being carried. The overall length is 611ft. 6in. and that at the water line 597ft., with a beam of 92ft. and a mean draught of 30ft. The armament of the "Giulio Cesare" comprises ten 12·6in. guns, twelve 4·7in. guns, with eight 3·9 A.A. guns and thirty-six A.A. machine guns. The armament of the other two battleships differs slightly as regards the number and types of the smaller guns. The larger 12·6in. guns, which are of a late Terni model and are 43·8 calibres in length, remain the same, but the calibre of the twelve guns composing the secondary armament is increased from 3·9in. to 5·3in. There are ten 3·5 A.A. guns and thirty-nine A.A. machine guns. Four aircraft are carried, there being two sets of launching catapults. The armouring of the magazines, machinery spaces, and boiler-rooms was increased during the reconstruction. The armoured belt varies amidships from 9¾in. to 8in., with 5in. at the ends. The barbettes are covered with 9¾in. armour and the turrets to the barbettes and the conning tower with 11in. armour. The propelling machinery for these battleships consists of a twin-screw arrangement of Belluzzo geared turbines having a designed output of about 75,000 S.H.P., corresponding to a speed of 27 knots. Steam is generated in eight three-drum oil-fired boilers, which are reported to have a working pressure of 500 lb. per square inch. About 2000 tons of oil fuel is carried. It is probable that up to the time of the Armistice the Germans kept the Italian naval ships very short of fuel and lubricating oil supplies Several units only managed to get to Malta with empty oil tanks and had to refuel before going to their allotted places.

The "Regolo" class of cruisers represented by the "Pompeo Magno," consists of twelve ships, some of which were reported delivered in 1942. They are of 3362 tons displacement and have a length of 444ft. 6in., a beam of 44ft. 9in., and a mean draught of 13ft. They carry eight 5·3in. guns, six 65 mm. guns, and fourteen A.A. guns. Eight 21in. torpedo tubes are fitted. The armour is slight. Twin-screw geared turbine machinery is installed, taking steam from four three-drum oil-fired boilers. The designed output is 120,000 S.H.P., corresponding to a speed of about 41 knots. The "Pompeo Magno" was built at Ancona yard of the Riuniti Company.

Among the more recent cruisers are the two ships of the "Condottieri" "E" class, which are known as the "Garibaldi" class. They are the "Giuseppe Garibaldi" and the "Luigi di Savoia Duca Degli Abruzzi." Both these ships were laid down in December, 1933, and were completed in 1937. The first named was built and engined at the San Marco yard of the Cantieri Riuiniti dell Adriatico and the second by the Odero-Terni-Orlando concern. They mount ten 6in. guns and eight 3·9in. guns, with eight 37 mm. A.A. guns and eight 13 mm. A.A. guns. Two sets of depth charge thrower gear are fitted. The displacement of these ships, which are but lightly armoured, is 7874 tons, the measurements being 613ft. 9in. overall and 593ft. on the water line, the beam being 61ft. and the mean draught 17ft. The complement is about 600. Four aircraft are carried with two catapults. There are six 21in. torpedo tubes, and the cruisers are also equipped for the laying of mines. Twin-screw Parsons geared turbines are installed, which have a designed output of about 100,000 S.H.P., corresponding to a speed of about 35 knots. The boilers, which are oil fired, are of the standard three-drum pattern and are eight in number. About 1200 tons of oil fuel is carried.

The cruisers of the "Condottieri" class "D" type, known as the "Emanuele Filberto" class, have a standard displacement of 7283 tons, or 8500 tons fully loaded. The "Emanuele Filberto Duca D'Aosta" was constructed at the Odero-Terni-Orlando yards, being begun in 1932 and completed in 1936. She is an enlarged edition of the "Montecuccoli" class of cruiser, and is lightly constructed. Her principal dimensions are 610ft. 3in. overall with 592ft. on the water line. The beam is 57ft. 6in. and the mean draught 16ft. 6in., and the complement is 551. The armament comprises eight 6in. guns, eight 3·9in. guns, and eight 37 mm. and 13 mm. A.A. guns. Two sets of depth charge throwing gear are fitted. The cruiser carried three aircraft, one launching catapult being provided. Six 21in. torpedo tubes in two triple mountings are fitted and the ship is equipped for minelaying. The twin-screw Parsons geared turbine machinery takes steam from six three-drum oil-fired boilers. It has a designed output of 110,000 S.H.P., giving a speed of about 36·5 knots; 1200 tons of oil fuel is carried.

Another recently designed cruiser is the "Raimondo Montecuccoli," herewith illustrated, which represents a vessel of the "Condottieri" class "C" type. She was designed and built at the Ansaldo Sestri-Ponente yard and was laid down in October, 1931, and was completed in August, 1935. The standard displacement of this cruiser is 6941 tons, or 8000 tons fully loaded, and she carries about 522 officers and men. Her length overall is 597ft. 9in., with 577ft. on the water line, and 575ft. 3in. between perpendiculars. The beam is 54ft. 6in. and the mean draught 14ft. 9in. The main armament consists of eight 6in. guns and the secondary armament of six 3·9in. guns, eight 37 mm. and eight 13 mm. A.A. guns, along with two sets of depth charge thrower gear. Three aircraft are provided for and one launching catapult is used. The armour of this class of ship is somewhat thicker on the water line. Four 21in. torpedo tubes are carried and the ship is equipped for minelaying. During her trials in August, 1935, the "Raimondo Montecuccoli," without stores or ammunition, recorded a maximum speed of 39·4 knots. Her designed speed is about 37 knots, the machinery comprising twin-screw Belluzzo turbines, taking steam from six three-drum oil-fired boilers. The total output of the turbines is given as about 106,000 S.H.P.

Enough has been said to indicate the important nature of the Italian battleship and cruiser fleet now surrendered, which will make a welcome addition to Allied sea power.

H.M.S. "PUCKERIDGE."—The Board of Admiralty has announced with regret the loss of H.M.S. "Puckeridge," a destroyer of the "Hunt" class.

W. T. Henley's Education Scheme

WE have received a copy of an illustrated booklet which is handed to every boy on entering the service of W. T. Henley's Telegraph Works Company, Ltd., and Henley's Tyre and Rubber Company, Ltd. This booklet outlines a scheme which is intended to enable all youths joining the Henley organisation to see what chances there are open to them and how they can train themselves for their careers. The scheme was launched in 1942, and at the inaugural general meeting, Sir Montague Hughman, the chairman of the Henley organisation, spoke of the opportunities available to all boys who took advantage of the educational facilities provided by the company. He mentioned, too, the work done by Dr. P. Dunsheath, director and chief engineer of W. T. Henley's Telegraph Works Company, Ltd., who, as chairman of the Education Committee, has been largely responsible for the success of the scheme.

Every boy is given the option of undertaking a course of training extending over a period of years. On a selected day each week, boys who have shown that they can benefit from such privileges and have been accepted for the course are released entirely from their normal duties with the company in order that they may attend approved classes at selected educational institutions near to their place of employment. They are expected to devote themselves wholeheartedly to the courses laid down for them during this day, and to attend a recognised educational establishment of their own choosing, at least one other evening in the week, for which purpose, wherever practicable, they will be released from shift work or overtime. In addition, they must undertake to carry out the homework in connection with their day course to the satisfaction of the education authorities. The subjects selected for the day periods are of a more serious and fundamental nature, but a good deal of freedom is given in the selection of subjects for the evening courses. Boys are paid for the time spent at the day establishment and all fees, both for the day and evening courses, are paid by Henley's.

The scheme is not only intended to produce better workmen, better foremen, better managers, but also better citizens, and in addition to every encouragement being given to the boys to enlarge their mental outlook, physical training classes form an important part of the scheme. Were the founder of the firm alive to-day, he would assuredly, remembering his own early days, look beneficently upon the scheme. Coming to London in 1830 as a lad of sixteen years of age, Henley, who for five years previously had been working in his grandfather's business as fellmonger and glover at Midhurst in Sussex, obtained work as a dock labourer. In spite of low wages and long working hours, he devoted himself to study, and having acquired a knowledge of scientific subjects, began constructing electrical instruments, particularly in connection with the electric telegraph, as well as devising machines for making insulated wires. In 1837 he founded the business which has since grown to the world-famous enterprise which still bears his name.

THE LATE MR. CONRAD VANDERMIN.—We regret to have to announce the death, on August 30th, of Mr. C. Vandermin, of the British Thomson-Houston Company, Ltd. Mr. Vandermin was born in London in December, 1888, and was educated at Dulwich College, Faraday House, and City and Guilds College. He entered the B.T.H. works at Rugby in 1911 and—except during the 1914–18 war, when he served in France—had been with the company ever since, first in Rugby as an A.C. machine designer and as a commercial engineer on motor sales, then in London as manager of export lamp sales, which post he had held for the past fifteen years. While in Rugby he studied law and was called to the Bar in 1928. He was also a director of the Isle of Thanet Electric Supply Company, Ltd., the Kalgoorlie Electric Power and Lighting Corporation, Ltd., and the Timbang-Deli (Sumatra) Rubber Company, Ltd.

The Engineer

SEPTEMBER 17, 1943

VOL. CLXXVI No. 4575

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MALLET LOCOMOTIVE REVIVAL

NOT least among the features which have characterised locomotive engineering since war began has been the increased tempo of construction of articulated engines. This may be observed best in America, though it is by no means confined to that country. Witness the construction of something approaching a "standard" Beyer-Garratt, which should have a large application throughout at least one continent. But in the Western Hemisphere it is the Mallet which holds sway, and of the 489 steam locomotives ordered in the States this year, 138 are on the Mallet principle. Construction has been sanctioned mainly in order to cope with intense war freight traffic, yet emphasis should be given in passing to the tendency of certain railways in recent years to edge towards some of the features of articulated locomotives for high speeds, not merely by the construction of express passenger Mallets, claimed to be suited to speeds of 70 m.p.h. or more, but by the adoption of double sets of drive and driving wheels as in the 4–4–4–4 and 6–4–4–6 engines of the Pennsylvania, the latter of which, incidentally, recently attained a speed of 101 m.p.h. with a trailing load of 1250 tons.

Despite the train weights now hauled in America, the Mallets of the war period have all been of one or other of the double six-coupled or eight-coupled wheel arrangements, whereas in earlier years the largest locomotives, *e.g.*, the Virginian 2–10–10–2 engines which for so long held the record as the world's heaviest locomotives, were mainly of the ten-coupled types, though the celebrated Erie triplex 2–8–8–8–2 struck an unusual and unrepeated note. This reduction in the number of coupled wheels is due mainly to the somewhat heavier axle loads now permitted over selected sections, which in turn are due partly to improved balancing practice; to the better use of any given adhesion weight by improved rod and valve proportions and events; and to a reduction in the power absorbed in propelling the locomotive itself. Again, many of the earlier ten-coupled designs were used as bankers for heavy coal trains, whereas all the Mallets of recent years have been strictly haulage power. In other words, in place of a very high starting effort maintained up to 10 m.p.h. or less, the newer engines have the same or a slightly lower peak effort, which can be maintained with little or no diminution up to a much higher track speed. This increase in effective horsepower of the newer Mallets results from superior boiler and superheater performance, enabling the production of a greater initial output, which can be made effective at the wheel rims through the better valve, valve motion, and front end design, and a lesser proportion of which is lost between the driving gear and the draw-bar because of a more extended use of roller bearings and improved lateral motion control devices. There remains still what perhaps, from a cursory inspection, may be deemed the most notable difference between present-day Mallets and the older models which made the name a household word in railway engineering, and that is the use of four-cylinder simple propulsion with cylinders 21in. to 26in. diameter in place of four-cylinder compound drive with enormous low-pressure cylinders—up to 48in. diameter. This in itself should have resulted in sounder mechanical construction, and greater machine efficiency and day-to-day running performance. Even a *prima facie* theoretical loss in the thermal efficiency is probably more than compensated by the higher pressures, higher superheat, and well-arranged valve events of present-day engines.

Because of what, in effect, is a centralisation of much of the extra war traffic, articulation has in some cases brought benefits additional to a simple increase in practicable train loading, which is the immediate reason for the recent concentration on Mallet construction. On the short Clinchfield Railroad in America, for example, the number of engines regularly in steam has been approximately halved as a result of adopting Mallets in place of smaller single-frame locomotives. Among recent additions to U.S. Mallet stock, heavy coal and mineral locomotives are exemplified particularly by the Chesapeake and Ohio 2–6–6–6 engines, which have more than 10,000 square feet of heating and superheating surface and the long piston stroke of 33in., and by the eighteen engines of the 2–8–8–4 type which have been delivered to the Duluth, Missabe and Iron Range Railroad for the haulage of 6000-ton ore trains from the Minnesota ranges to the docks on Lake Superior. These eight-coupled locomotives have four 26in. by 32in. cylinders, 63in. wheels, a working pressure of 240 lb., an engine weight of 312 tons, and a combined engine plus tender weight of 508 tons. Of similar size, but of the well-known "back-to-front" construction favoured for the Californian steeply graded tunnel sections, are the seventy oil-burning 4–8–8–2 passenger and freight engines built or put under construction in 1942–43 for the Southern Pacific. For service over the Rockies, the Union Pacific has concentrated on 4–6–6–4 and 4–8–8–4 classes for the heaviest passenger and freight trains, and has sixty engines of the 4–6–6–4 type, with a further twenty-five under construction, all of which have a working pressure of 300 lb. The freight class, of which there are twenty, are, at 535 tons, reputed to be the largest and heaviest steam locomotives in the world. A dozen 4–6–6–4 engines have been built for the Northern Pacific, fifteen for the Delaware and Hudson, and twenty have been ordered for the trans-Allegheny coal traffic of the Baltimore and Ohio, a railway which had acquired no new articulated locomotives for a good many years. Finally, the Norfolk and Western is building fifteen Mallets of the 2–6–6–4 type at its own works at Roanoke.

The post-war future of the Mallet may not be so assured as these figures might be taken to indicate. The recent pay concessions to driving crews, and the further demands, based on nominal horsepower instead of adhesion weight, have increased the operating charges to be borne by very large locomotives in America, and the high output over a big speed range which characterises the modern Mallet may be a financial disadvantage when, as is proposed in the various official and semi-official schemes for post-war economics, money is again rated at a higher priority number than physical facts and possibilities.

Civil Flying

SOME months ago we suggested how a rough forecast might be made of the probable scale of aircraft manufacture in the post-war years. The suggestion was that the aggregate requirement could hardly be expected to exceed 10 per cent. of the present output, even when full allowance had been made for aircraft for military and police purposes. Such a considerable reduction in the rate of manufacture as 90 per cent. may to some have appeared drastic, but it was confirmed a few days later with the high authority of our Minister of Aircraft Production. Nevertheless, it has not been universally accepted. Speaking recently in the House of Peers, Lord Londonderry, once a Secretary of State for Air, called such an admission "something akin to defeatism," though he was corrected

by Lord Brabazon—who had been a Minister of Aircraft Production—on the ground that in the years before the war the admittedly air-conscious American public, with their vast distances to cover, found that as few as 370 civil air transport aircraft sufficed to meet their needs. On the other hand, the Civil Aeronautics Administration of the United States is alleged "soberly to contemplate" that before 1950 there may well be "half a million private, commercial, and military planes" in that country.

With such a variety of counsel as this, where does the truth lie? We have at least some facts to go on and these show that, between the years 1919 and 1937, the mileage flown by the regular air services of the whole world increased thirty-fourfold in the first half of that period and sixfold in the second. The slowing down in the rate of increase is what might have been expected and it suggested some approach, if not to saturation, at least to a steady rate of growth. It may be urged that the present war will have changed all that; certainly we know better now how to build aircraft economically, how to lessen some of the running costs, and how to lower the accident rate; Mr. Warner showed in his recent Wilbur Wright Lecture that on the U.S.A. Air Lines the average passenger fatalities per passenger mile flown had decreased by nearly 90 per cent. between 1929 and 1942; albeit there is still a good way to go before the low rate of accidents on railways is approached. Those who are reluctant to admit that there must be an immense reduction in the current rate of aircraft manufacture base part of their case on an expected huge growth in demand for privately owned aircraft. In this field America has so far led the world, for in 1937, of the total number of 10,836 of her civil aircraft, only 415 were regular air liners. The immense majority were privately owned. The ratio of these numbers is about twenty-five to one, but it must be borne in mind that the ratio in tonnage would be vastly less; on that we have no actual figures, but it may well be no more than two or three to one. In Great Britain the corresponding figures were 1660 for the total number of civil aircraft, of which a tenth were regular air liners; similar ratios in Canada and Australia were one-sixth and one-third. Hence if privately owned aircraft are to make much showing in total production, it is in America, if anywhere, that that is likely to happen. In pre-war days America possessed half the total number of civil aircraft in the whole world. But even with these figures before us, is it possible that there can be any reasonable basis for such a forecast as 500,000? Military and police purposes can hardly call for more than 20,000, so if the estimate is to be justified the American public have got, by the year 1950, to become more than forty times as air-minded as they were before the war! Even if this astonishing thing did happen, the privately owned tonnage would hardly amount to more than the equivalent of some 100,000 military aircraft, and that, on the basis of a five years' life, would only call for a tonnage replacement rate of some 20 per cent. of the huge rate of American production which is likely to rule by the end of this present year.

In a small island like ours there is, especially in comparison with America, little room for internal air services on any such scale, and the public, despite their general keenness on flying, would surely have strong views if the privacy of ear and eye were invaded beyond a certain point. There are but 58,000 square miles in the whole of England and Wales, and even if our air enthusiasts let us off with as few as 50,000 aircraft and they were to fly for but one hour in each of the twenty-four, simple arithmetic shows that on the average there would be aircraft visible or audible in every little area of no more than 3 miles radius at all times of the day and night. In that event the case for limitation might prove strong enough to become a leading political issue at the next ensuing General Election!

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THIS FREEDOM

SIR,—May I be allowed to congratulate you on your leading article in your issue of September 10th?

In any discussion of the question of individualism *versus* collectivism it must be borne in mind that the unexampled expansion of commerce which characterised the nineteenth century took place under a system of individualism; from the beginning of the 1900s the State has tended more and more to exert pressure and influence on the organisation of business, and to many of us this appears to have been accompanied by a progressive decline in prosperity and a progressive increase of discontent in the working population, allowing, of course, for the differences in the style of living between then and now.

It may be said of the nineteenth century that it saw nothing good outside individual enterprise, but there is becoming more and more evident in these days a tendency to see nothing good outside State control. The truth, as always, lies somewhere between the two extremes. We cannot drop at once all forms of State interference in economic affairs, but at the same time we cannot allow it to grow until it stifles all individual freedom and all enterprise.

The problem is at root a spiritual one. Is the individuality of the individual a sacred thing, or is the individual merely a tool to be used as the State dictates? On the answer to this question which is given in the post-war years will depend the happiness or the misery of the people of this country perhaps for centuries to come.

W. J. CHAMBERS.

W. Kensington,
September 10th.

INTERNATIONAL ENGINEERING

SIR,—It must be disappointing to Mr. Carr that no notice was taken of his letter published in your issue of August 20th on the above subject.

I am interested in the Federation, not only of engineers, but of the whole body of professional men and women; but, as a matter of policy, national federation should precede international.

I note with pleasure that the federal idea is beginning to permeate professional bodies. The engineers and the accountants (about whom we may hear more shortly) are now considering co-ordination. The question of closer contacts between industry and professions is also undergoing serious consideration. I see no reason why both these ideas should not be carried out. Lord Portal asked that the whole building industry (professions and craftsmen) should speak to him with a united voice. This collaboration is, however, quite a separate matter from the delimitation of various professional frontiers, the elimination of redundant associations and much more.

The Chartered Surveyors' Institution belongs to the International Federation of Surveyors. The Federation held its last meeting at Rome just before the outbreak of war.

I envisage a world in which nations and boundaries will count for nothing as such, but a world which will co-operate as a single unit for the benefit of all, when all the earth's resources will be for the benefit of all, when there will be social security for all. These ideas are now being preached by all responsible statesmen and leaders of thought. The war is a world war and the peace must be worldwide.

A. W. CRAMPTON.

Woodchurch Road, N.W.6,
September 11th.

Sixty Years Ago

PROFESSOR ARTHUR CAYLEY

IN 1883 the British Association met at Southport under the presidency of Arthur Cayley, Sadlerian Professor of Mathematics at Cambridge. Contrary to our usual custom, we did not reproduce his inaugural address, either wholly or in part. It dealt, we said, from first to last with transcendental mathematics and "was as dry and uninteresting as it was possible for a man whose type of beauty is the fifth book of Euclid to make it." It was certain, we continued, that not fifty people who heard the address understood it and that not one-half of these enjoyed it. Professor Cayley, we asserted, lacked the poetical element, which enabled some men, notably Clerk Maxwell, to invest the driest matter with charm. He was a profound mathematician first and a suitable man to address the British Association a long way afterwards. Our readers, we wrote, would feel that we had acted for the best in declining to fill our columns with page after page of disquisitions on such matters as space of one and four dimensions. Of its kind, the address was perfect—deep, accurate, and far-seeing—but it was carefully divested of all charm of composition. It was not customary, we concluded, to condemn addresses such as that of Professor Cayley, but on this occasion we thought it well to depart from the custom. . . . To-day Cayley is recognised as a mathematician to be classed for his prolific inventiveness only with Euler and Cauchy. His work within recent years has proved extraordinarily fruitful. In particular, his study of the geometry of "higher space," his theory of invariants, and his theory of matrices have had vital repercussions on the development of the theory of relativity and the quantum theory. Yet with the exception of a single short passage in his Presidential Address of 1883, he never expressed himself in any style less severe than that of a precise mathematical statement. In that respect he differed remarkably from his close friend, Sylvester, who, in the words of a modern writer, Professor E. T. Bell, could hardly talk about mathematics without at once becoming almost orientally poetic. Nevertheless, the two men were not only friends; they inspired one another to some of the best work that either of them did.

BOOKS RECEIVED

Aeroplane Production Year Book and Manual. Edited by G. W. Williamson. London: Paul Elek (Publishers), Ltd., Africa House, Kingsway, W.C.2. Price 40s. net.

Understanding Aircraft Components by Question and Answer.—By W. Hazell. London: English Universities Press, Ltd., St. Hugh's School, Bickley. Price 2s. 6d. net.

Modern Railway Signalling Practice in America

By O. S. NOCK, A.C.G.I., B.Sc., A.M.I. Mech. E.

No. IV—*(Continued from page 205, September 10th)*

Centralised Traffic Control

THE name centralised traffic control (or C.T.C.), as used in America to describe the system of remote signalling control utilising coded currents, is open to some misinterpretation in this country. In Great Britain the term "traffic control" refers in general to the regulation of train movements by one central and a series of district control offices. Individual signalmen conduct the

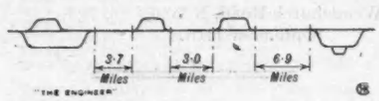


FIG. 28

actual movements according to a prearranged plan, but any variation from this plan, either to accommodate extra traffic or to cope with an emergency, is initiated or requires authorisation from "Control." Communication between the control offices and distant stations is by telephone. In America the C.T.C. system was devised for use in somewhat analogous circumstances, except that there were usually no signals and no signalmen. Train movements were directed by means of orders telegraphed from traffic controllers to local stations, where the telegraph operators handed a written copy of the order to the conductors of the trains concerned.

The original function of C.T.C. was to eliminate this cumbersome transmission of messages, and with it the attendant handicap of trains having to be stopped to receive their orders; and to give traffic controllers, or train dispatchers as they are frequently called, a means of controlling train movements direct by signal indication. But already the system has developed far beyond this original function. From being a special system to be used for the control of traffic on single lines, C.T.C. is now coming to be recognised as a standard form of signalling, to be operated by the ordinary signalmen—as distinct from train dispatchers—and capable of use in any locality, where the track lay-out and the general run of traffic make it desirable to bring an extensive area under the control of one signal cabin.

The track diagram in Fig. 28 shows a typical stretch of single-line railway, as found in the Middle West, and for which C.T.C. has been found eminently suitable. It forms part of an installation covering about 100 route miles where all train movements are under the direct control of one man—the train dispatcher at the divisional point. All signals and points at the twenty intermediate stations and loops are controlled by coded currents using only two line wires throughout. Each code transmitted on the line wires consists of sixteen periods when the current is first "on" and then "off" alternately. The "on" and "off" periods may be long or short, and by varying the order in which the "longs" and "shorts" are transmitted a large number of codes can be arranged. The first periods, or impulses as they are sometimes termed, are used to select the particular station, while the later ones initiate the operation of the points or signals required. Fig. 29 shows the lay-out at a simple passing loop, and also illustrates the code transmitted in order to clear the westbound starting signal for a train leaving from the main track. Although there are eight signals and two pairs of points, such a loop would require only four thumb switches on the control panel, as one three-position switch can control four signals. With the switch in the mid-position all four signals are at danger; when moved to the left one or other of the westbound signals is cleared, which particular one depending upon the lie of the points. Similarly, when the switch is moved to the right the appropriate eastbound signal clears.

Transmission of Codes

The principle on which codes are transmitted is shown in the schematic diagram in Fig. 30. The thumb switches on the control panel are moved to the desired positions, and the pressing of a starting button, shown in Fig. 29, initiates the operation of a step-by-step device in the control machine; the corresponding unit at the remote station responds in synchronism until the line circuit is completed between the thumb switch contacts on the panel and the control relays for the particular signal or point machine at the station selected. The principle used is thus similar to that of automatic telephone switching, but in C.T.C. the step-by-step device consists of a series of relays instead of a rotary preselector switch. Referring again to Fig. 29, it will be seen that the first period of the code is used for line checking. When the starting button is pressed the first action is to prove that the line is clear, that is, that no other codes are being transmitted. In such a scheme of remote control it is essential for the functioning of every signal, point machine, and track circuit to be indicated on the control panel; and in registering any change in conditions—as, for example, the entry of a train on to a track circuit—the distant stations act as code transmitters, and one such code might well be coming in just as the dispatcher initiated the sending out of a control code. Thus the line must be proved clear before another code can be sent out.

Each station, and the control machine, too, have what is termed a "master relay," and according to whether this relay is energised or de-energised so the station in question is ready to act respectively as a transmitting or receiving unit. The functioning of the master relay also controls the case where two stations begin transmitting indication codes simultaneously; the circuits are so arranged that the energisation of the master relay at the station nearest to the control machine cuts out the corresponding relay at the more distant station, and the transmission of the code from the latter is held up until the nearer station has completed its transmission. Occasions thus frequently arise when codes have to be stored until conditions

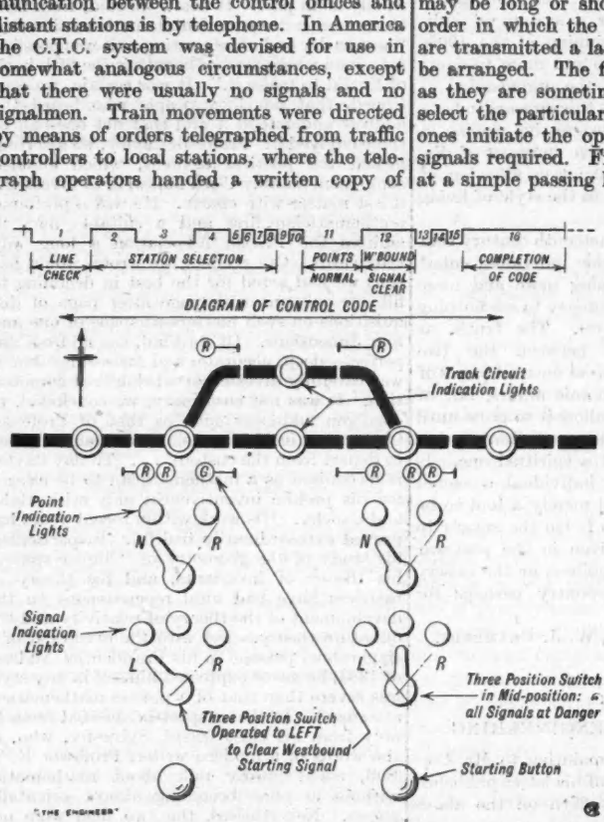

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
LINE CHECK
STATION SELECTION
POINTS NORMAL
W'BOUND SIGNAL CLEAR
COMPLETION OF CODE
DIAGRAM OF CONTROL CODE
Track Circuit Indication Lights
Point Indication Lights
Signal Indication Lights
Three Position Switch Operated to LEFT to Clear Westbound Starting Signal
Three Position Switch in Mid-position: all Signals at Danger
Starting Button
"THE ENGINEER"

FIG. 29—LAY-OUT OF SIMPLE PASSING LOOP

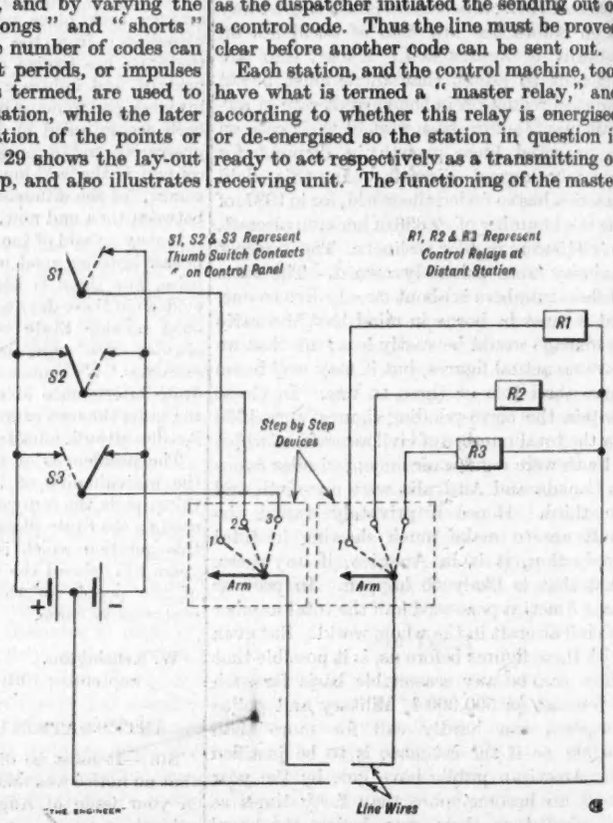


FIG. 30—ELEMENTAL PRINCIPLES OF C.T.C. CODE TRANSMISSION

on the line wires are favourable for transmission. We will suppose that in consequence of a train movement at a distant station "AA" a certain track circuit becomes occupied; the de-energising of the track relay concerned initiates the transmission of an indication code, in the same way that the action of the dispatcher in pressing one of the starting buttons on the control panel initiates the sending out of a control code. At the same time as this distant station "AA" registers the change in track circuit condition the dispatcher is in the act of sending out a control code to another station. For him to be doing this the master relay at the control office must be energised and the master relays at all the outlying stations de-

FIG. 31—C.T.C. MACHINE

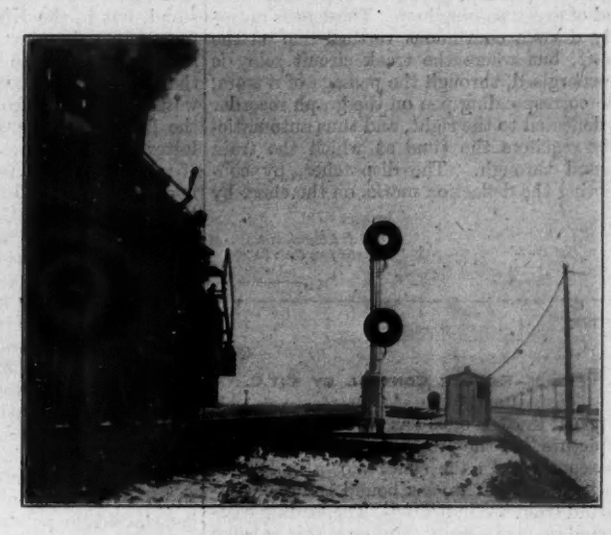


FIG. 32—NON-STOP "MEET" ON BURLINGTON ROUTE

energised. At "AA" all other conditions for transmission of a code to the office are fulfilled, and as soon as the code being sent out by the dispatcher is complete the master relay at "AA" picks up and transmission begins. Actually about 3¾ seconds are taken in sending either a control or indication code.

The two-wire system, as illustrated in Fig. 30, has a maximum capacity of thirty-five "stations," the term station referring here to a single location, as, for example, the points and associated signals at one end of a passing loop. This maximum capacity concerns only the number of stations on one line circuit, so that if the control machine was installed at about the mid-point of a long section of line to be signalled it would be possible to control thirty-five stations in each direction, seventy in all. By using a three-wire system eighty-one stations can be controlled on one circuit, though the most recent developments in C.T.C. to be described later have extended, almost indefinitely, the capacity of the two-wire system. The photograph reproduced in Fig. 31 shows a typical control machine. The case is constructed in three sections, the outer ones so inclined to the central section that all the control switches are within easy reach of the dispatcher.

The functions that can be controlled at the distant locations are not confined to signals and power-operated points. Some locations may be more extensive than the simple passing loop illustrated in Fig. 29; additional siding accommodation may be provided, as shown in Fig. 31, though the points giving entry to such sidings are not used often enough to justify their being worked by power. For lay-outs of this kind electric switch locks are installed; these are released by the C.T.C. system, so permitting the points to be thrown by hand. It should be explained that while points, signals, switch locks, or any other functions are controlled from the distant office, by coded currents, all the usual interlocking between such functions is provided in the local electric controls at each station. So that if the dispatcher inadvertently attempted to signal the departure of a train from a loop on to a single-line section already occupied, the track circuit locking would prevent the signal being cleared. The dispatcher, not receiving back the indication code after the usual seven or eight seconds, would have his attention drawn, automatically, to the fact that some irregularity had occurred, and would be quick to discover his mistake.

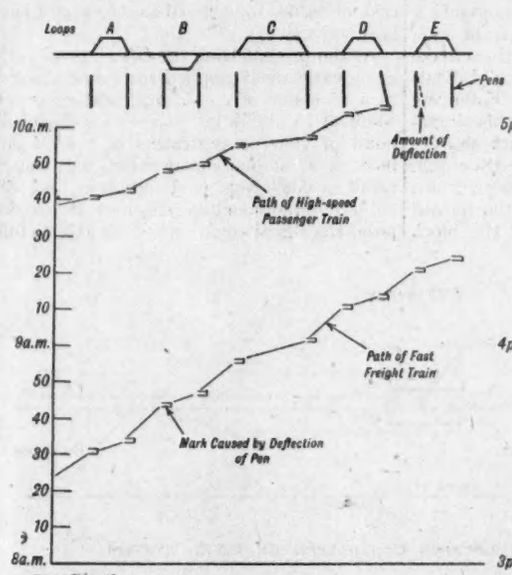


FIG. 33—TYPICAL GRAPH RECORD

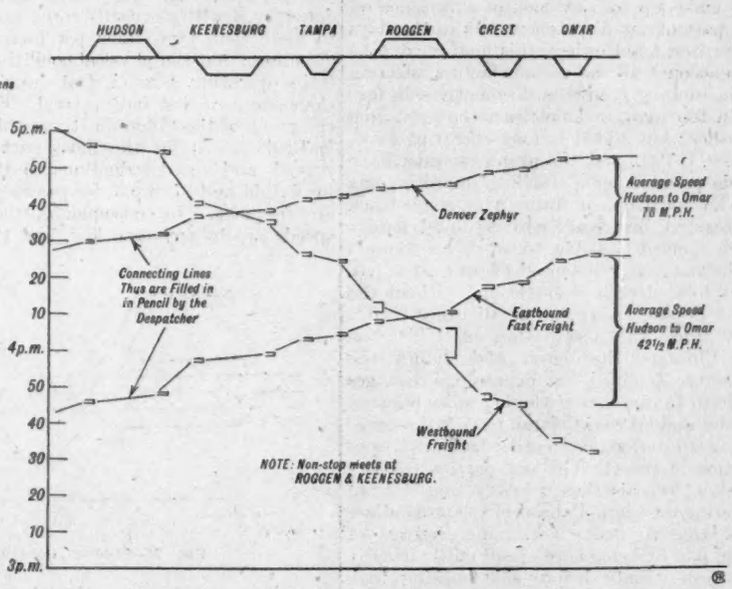


FIG. 34—PORTION OF GRAPH RECORD

AUTOMATIC GRAPH RECORDER

The illuminated track diagram provides, at any time, complete information as to the whereabouts of every train in the section of line controlled, though where different classes of traffic are concerned it is not perhaps the easiest of tasks for the dispatcher to antici-

pate the most favourable points at which to cross opposing trains. It is for this purpose that the automatic graph recorder is so valuable. This device can be seen mounted in the desk immediately in front of the operator in Fig. 31, while Fig. 33 shows a portion of the chart produced. There is a pen corresponding to the track circuit at each end of every passing loop. These pens normally draw a continuous vertical line on the chart, but where the track circuit relay is de-energised, through the passage of a train, the corresponding pen on the graph recorder is deflected to the right, and thus automatically registers the time at which the train passed through. The dispatcher, by connecting the deflection marks on the chart by

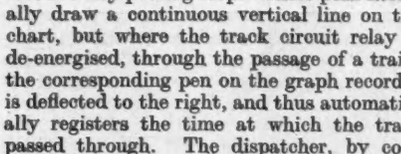


FIG. 35—REMOTE CONTROL BY C.T.C.

a pencil line, at once has before him a vivid "picture" of the progress of all trains under his control. In the chart shown in Fig. 33 the positions of two eastbound and one westbound train are indicated. The leading eastbound train is a fast freight, and this is being followed by a streamlined diesel-powered express passenger train making an average speed of 80 m.p.h. The dispatcher has to decide the best meeting point for these two trains with a heavy westbound freight of sixty cars, bearing in mind all the time that arrangements will have to be made sooner or later for the streamliner to overtake the eastbound freight.

The ideal "meet" is one in which neither train is stopped. In aiming at this ideal, however, the automatic graph recorder will not make up for any lack of experience on the part of the dispatcher. As in the days of written train orders, this man must take into account all the various factors affecting train running gradients, locomotives in use, train tonnages, and not least the prevailing weather; but added to long operating experience, C.T.C., and the graph recorder have made possible some startling improvements in the operation of trains over single-track routes. A few years ago it would hardly have seemed possible to work an express train at an average speed of over 70 m.p.h. on a long stretch of single line without the most drastic treatment of all other traffic. Yet since the installation of C.T.C. on the Chicago, Burlington and Quincy the "Denver Zephyr" has maintained averages of 70 to 75 m.p.h. over the 112 miles between Derby and Akron, Colorado, with the minimum of interference to other traffic. Examination of the chart of one particular day's working reveals that a heavy freight train entering the section ahead of the streamliner was able to make a running average of 43 m.p.h. by being kept ahead until virtually the last minute before side-tracking took place, and then being given the road immediately the streamliner had cleared. Two freight trains in the opposite direction suffered no delay at all at the crossing points, passing both the eastbound freight and the eastbound "Denver Zephyr" without stopping. This latter may well seem to be a piece of pure luck, though the frequency with which it happens in C.T.C. territory, as shown by the train graphs, hardly confirms this somewhat natural first impression.

OPERATION ON BURLINGTON ROUTE

Fig. 34 is a reproduction of portion of an actual train graph recorded on this section of the Burlington route, and shows non-stop meets between a westbound freight and two fast eastbound trains, the second of these being the "Denver Zephyr." From the chart it will be seen that the westbound freight approached Roggen loop slowly, under a caution signal, to avoid coming to a stand, but in the Keenesburg "meet" it is remarkable, in view of the comparatively near approach of the "Denver Zephyr," that the dispatcher felt confident in advancing the westbound freight from Tampa. At the time the freight was signalled forward from the latter place the streamliner was only about 15 miles to the west, and travelling at approximately 90 m.p.h.! In this particular installation the use of C.T.C. obviated the need for considerable extra track mileage in the shape of double-track sections, which would otherwise have been necessary, for the reception of freight trains to keep them moving, and for the provision of clear paths for the high-speed passenger trains. The photograph reproduced in Fig. 32 shows an actual non-stop "meet" in progress, at Bijou loop on this section; an eastbound freight is shown passing, at full speed, the signals at entrance to the loop, while in the distance the westbound train is steaming slowly forward ready to go ahead as soon as the eastbound train has cleared the points.

In this Burlington installation the principal operating problem arose from the diversity of train speeds. In mountain country equally difficult conditions are often experienced, where on account of the heavy loadings of freight trains it is especially desirable to avoid stops at passing loops, wherever possible. The main line of the Denver and Rio Grande Western Railroad provides an excellent example of this second class of C.T.C. installation, in the 38-mile long bottleneck through the Glenwood Canyon, Colorado. The traffic is not very dense, by British standards, rarely amounting to more than two trains per hour in each direction; but the physical conditions make train operating a good deal more difficult than might at first be supposed. Following the gorge of the Colorado River, this single-tracked line is for the most part sharply curved, and speed reductions to 18 m.p.h. for freight and 27 m.p.h. for passenger trains are frequent. In consequence, the overall speeds are in any case low, and the block sections occupied for long periods at a time. Individual freight trains are extremely heavy, ranging up to 2700 tons, and with a ruling gradient of 1 in 70 there is a possibility of much time being lost through stops at crossing loops. On the critical section between Funston and Dotsero Junction, 9 miles long, there are four intermediate passing loops, and before the installation of C.T.C. it was not unusual for heavy freight trains to spend up to two hours in covering this section. C.T.C. has eliminated most of the time previously spent waiting at loops, by enabling the dispatcher to arrange more suitable meets; while a further great improvement has resulted from the power operation of all points, instead of the hand operation by train crews previously in use. In this installation it was considered worth while to use a three-wire scheme, so that control and indication codes could be sent simultaneously, thus enabling the dispatcher to send out control codes more rapidly.

C.T.C. IN ORDINARY SIGNALLING

Turning now from what may be termed "dispatcher control" to more conventional forms of signalling, a recent installation on the Chesapeake and Ohio provides an interesting example of the C.T.C. principle used in conjunction with simple automatic signalling to solve a particular operating problem. Fig. 35 shows the track lay-out diagrammatically. Two sections of double track were linked by a section of single track 11 miles long, and over this route there passes a heavy coal traffic. Local conditions made it impracticable to double the intermediate section, and so a remote control interlocking was designed to cover both ends of the single-line section, from a control panel at box A. The double-line sections on either side were equipped with simple three-aspect automatic signalling, but by extending the track diagram of the control panel at A to include several of the approach track circuits, the signalman is given a good "picture" of the occupancy or otherwise of the roads leading to the single-track bottleneck. This lay-out provides yet another example of the advantages derived from bringing all sections of a critical piece of railway under one control. From the traffic point of view it is just another instance of effective remote control, following upon the previous examples given in No. III of this series of articles. Its particular significance, however, lies in the use of coded currents for the control of points and signals 11 miles from the cabin; with direct-wire control the cost of cable, for this distance, would have been excessive.

At the present time the C.T.C. principle is being extensively applied for remote control in a diversity of conditions, and not solely confined to single tracks. From the traffic point of view concentration of control in a busy area, at one signal cabin, will usually result in much improved operation, and with modern remote control schemes at his disposal the signal engineer will be able to fulfil any traffic requirements. Whether direct-wire or coded control is used is largely a matter of economics; for comparatively short distances the direct-wire system will undoubtedly prove the cheaper, while for long distances the great saving in line wires possible with coded control will more than outweigh the cost of the coding apparatus. The extent of an area brought under coded remote control is no longer limited either by technical or economic considerations, but by the number of train movements that can be supervised simultaneously by one man. In discussing, in the second article of this series,

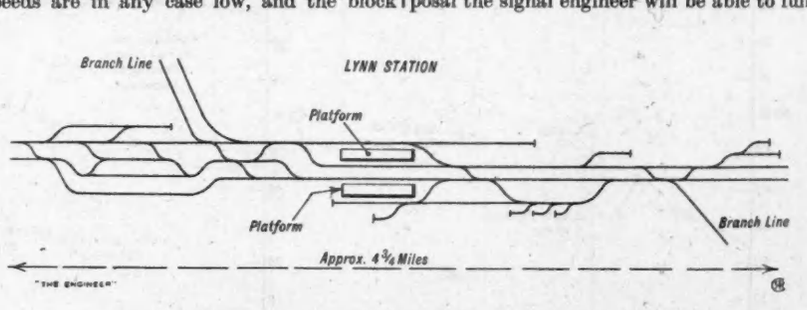


FIG. 36—SINGLE INTERLOCKING CONTROLLED ON C.T.C SYSTEM

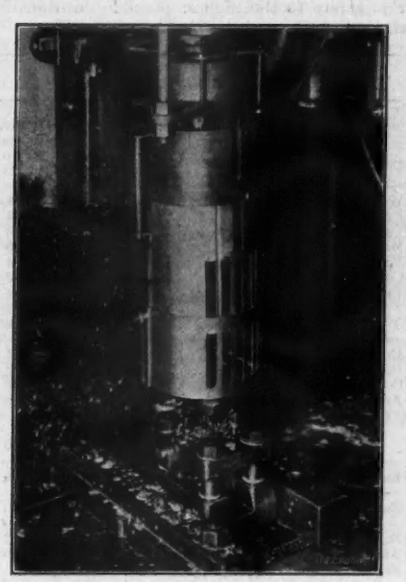
the route relay interlocking at Elizabethport, Central Railroad of New Jersey, it was mentioned that there are often six or seven movements simultaneously through that junction. In that case the interlocking area was compact and direct-wire control, with route switching, was employed. A somewhat similar lay-out, though extending over 4¾ route miles, is shown in Fig. 36, and illustrates the tracks at Lynn, on the Boston and Maine. Although extending over this considerable distance, it represents the type of lay-out that, for the most advantageous train operation, should be controlled from a single point. As actually equipped, this area provides an excellent example of the C.T.C. principle applied to the control of a single interlocking, as distinct from its use for direction of traffic over a wide area by a dispatcher. The signalman in charge of the C.T.C. type control machine at Lynn handles a heavy suburban traffic and many high-speed through passenger trains; only about 15 per cent. of the trains passing during the twenty-four hours are freight. In all sixty-nine functions are controlled from this one machine; all points are operated on the electric-pneumatic system, which, with one of the fastest mechanisms yet designed, permits of a control code being transmitted and an indication code received back in 2½ seconds.

Improved Drill Guard

ACCIDENTS in the drilling department are usually caused by loose clothing, long sleeves, and women operators' hair being caught in the revolving spindle, chuck, or tools. To reduce the number of such accidents drilling machine manufacturers have for many years fitted the upper part of the spindles with telescopic guards and similar devices, but many accidents are still caused by the lower part of the spindle, chuck, and tools.

The "Reliance" drill guard, illustrated herewith, for which Alfred Herbert, Ltd., Coventry, are sole agents, is fitted to the lower end of the drill spindle sleeve, with which it travels, when feeding the drill, until the lower end of the guard makes contact with an abutment on the jig. As drilling continues, the guard telescopes, so that the lower end of the spindle, the chuck, and tool is completely guarded throughout the operation. When the drill is withdrawn light springs return the guard to its original length. When setting up or changing tools in the chuck, the guard can be collapsed and retained in that condition by means of a catch. The back of the guard, away from the operator, is open to allow the free passage of chips.

The guard is made in three sizes. The first has an internal width of 2¼in., and is suitable for most machines using drill chucks for straight shank drills up to ⅝in. diameter. The second has an internal width of 3⅜in. and is suitable for machines having spindles with No. 1, 2, or 3 Morse taper hole for drill chucks using straight-shank drills up to ⅝in. diameter. The third is a special guard for machines with quick-change drill chucks. This guard comprises two sections only. It is spring-loaded, similar to the other two guards, and the lower part can be fixed in the top position when changing work. Space is provided in the guard to insert the fingers when changing tools in the quick-change drill chuck without stopping the spindle.



IMPROVED DRILL GUARD

Prefabricated "Railbars"

To meet wartime travelling conditions consequent upon the curtailment of restaurant cars and to provide a readily accessible means by which the largely increased number of passengers now travelling can obtain snacks to take with them on the trains, the railways have made provision for additional serving counter facilities. On the L.M.S. Railway these facilities take the form of two types of "Railbar." The first type was introduced at Euston in January of this year and is a permanent structure on the site of previous refreshment rooms, but with an open counter capable of dealing with a larger number of patrons than in the normal room.

"Railbars" to be installed at provincial centres are standardised unit buildings. These buildings are placed on the platform so that, together with the existing refreshment room, they create points along the length of the train at which tea and light refreshments can be obtained and so eliminate crowding and rush of traffic to one point on the platform. The first of these "Railbars" is to be opened at Crewe, and others will follow at Preston, Derby, Sheffield, and Rugby. At other principal stations existing buildings are being adapted to the "Railbar" principle.

The problem called for a special type of building. In the first case the "Railbar" had to be compactly planned with everything to hand to allow serving to be carried out with a minimum of staff. Secondly, rapid erection on the site was needed to eliminate interference with railway working. Thirdly, there were constructional problems arising from the need for the strictest economy in the use of building materials. The design adopted fills all these requirements. The new standard unit "Railbars" are prefabricated completely, right down to the inclusion of plumbing, lighting, and paint finish. The only site work is the running of services and drainage to a point adjacent to the "Railbar." This site work is carried out before the "Railbar" itself is delivered. The "Railbar," in order to facilitate transport, is delivered to the site in sections as follows:—(1) Pre-cast concrete floor units; (2) back section, consisting of shelving; (3) front section, consisting of counter, cash drawers, &c.; (4) two end sections, one consisting of door and frame, the other a panel containing all the plumbing, sink, &c.; (5) roof section containing all the lighting and ventilation hood for the hot water boiler. The whole structure can be easily loaded in one railway van. It is estimated that the erection and connecting up to the drains will take one day.

The Ministry of Works and Planning agreed that plywood should be released for these buildings. The normal studding which acts as a framing for walls is entirely eliminated, and in the back unit the shelves themselves act as a stiffening for the external wall facing. The "Railbars" are under the direction of Mr. Arthur Towle, Controller, L.M.S. Hotel Services. The design of the building is the work of Mr.

FLOOR, BACK AND END SECTIONS OF RAILBAR

COMPLETED RAILBAR

W. H. Hamlyn, the company's architect, and his staff. The contractors are Holliday and Greenwood, Ltd., of London.

The Weight of German Aircraft

FROM a report on the structure of eight main types of German aircraft supplied to us by the Ministry of Aircraft Production, we take the following data concerning the weights of three of them, two fighter-bombers and one bomber.

F.W. 190.A—3 (Fighter-Bomber)

	Weight, lb.	Weight, per cent. all-up weight.
Wings	1,113	13·0
Fuselage	520	6·1
Tail unit	150	1·7
Main undercarriage	480	5·6
Tail wheel unit	35	0·4
Controls	100	1·2
Engine mounting and cowling	250	2·9
TOTAL STRUCTURE	2,648	30·9
Engine and accessories	2,680	31·2
Airscrew and spinner	390	4·5
TOTAL POWER PLANT (EXCLUDING MOUNTING AND COWLING)	3,070	35·7
Fuel and oil tanks	275	3·2
Bare weight	5,993	69·9
Radio	90	1·0
Oxygen equipment	25	0·3
Electrical gear	150	1·7
Instruments, &c.	100	1·2
Armour	150	1·7
Fixed armament accessories	100	1·2
Removable armament	816	9·5
TOTAL EQUIPMENT AND ARMAMENT	1,431	16·7
Pilot and parachute	200	2·3
Fuel (115 gallons)	860	10·0
Oil (10 gallons)	96	1·1
ALL-UP WEIGHT	8,580	

Me. 109.F—1/2 (Fighter-Bomber)

	Weight, lb.	Weight, per cent. all-up weight.
Wings	748	12·4
Fuselage	742	12·3
Tail unit	80	1·3
Main undercarriage	240	4·0
Tail wheel unit	24	0·4
Controls	73	1·2
Engine mounting and cowling	146	2·4
TOTAL STRUCTURE	2,053	33·9
Engine and accessories	1,540	25·5
Radiators	150	2·5
Coolant	137	2·3
Airscrew and spinner	293	4·8
TOTAL POWER PLANT (EXCLUDING MOUNTING AND COWLING)	2,120	35·0
Fuel and oil tanks	157	2·6
Bare weight	4,330	71·6
Radio	70	1·2
Armour	60	1·0
Fixed and removable equipment and electrical gear	302	5·0
Removable armament	335	5·5
TOTAL EQUIPMENT AND ARMAMENT	767	12·5
Pilot and parachute	200	3·3
Fuel (88 gallons)	680	11·2
Oil (8 gallons)	77	1·3
ALL-UP WEIGHT	6,054	

Do. 217—1 (Bomber)

	Weight, lb.	Weight, per cent. all-up weight.
Wings	4,600	13·6
Fuselage	2,815	8·3
Tail unit	610	1·8
Main undercarriage	1,830	5·4
Tail wheel unit	135	0·4
Controls	600	1·8
Engine mounting, cowling, and nacelles	900	2·7
TOTAL STRUCTURE	11,490	34·0
Two engines and accessories	5,365	15·9
Two airscrews and spinners	785	2·3
TOTAL POWER PLANT (EXCLUDING MOUNTING AND COWLINGS)	6,150	18·2
Fuel and oil tanks	1,550	4·6
Bare weight	19,190	56·7
Armour	400	1·2
Fixed equipment	960	2·7
Removable equipment	610	1·8
TOTAL EQUIPMENT	1,910	5·7
Crew and parachutes	800	2·4
Fuel (655 gallons)	4,700	13·9
Oil (88 gallons)	800	2·4
Bomb load (approximate)	6,400	18·9
ALL-UP WEIGHT	33,800	

The Technical Training of Engineering Apprentices

TO-MORROW, Saturday, September 18th, a conference organised by the Manchester and Salford Trades Council is to be held at the Midland Hotel, Manchester, to discuss the technical training of engineering apprentices. A memorandum on the subject originally prepared by the Manchester District Committee of the Amalgamated Engineering Union and subsequently discussed by a committee formed of representatives of unions in the engineering industry is to be submitted as a basis for discussion by the conference.

The committee of the engineering unions is of the opinion that the time has arrived for a new outlook on this question in the engineering industry, having in mind the probability that in the post-war period the school-leaving age will be raised to fifteen or sixteen years, and wider opportunities of secondary school education provided. The way, it holds, is open for a much-needed advance in the technical training of the future craftsmen in the industry. It is suggested that under an intensive system of training such as is now possible, the four years from seventeen to twenty-one years of age could, if properly utilised, give an adequate foundation for a successful career.

In order that the subject may be clearly examined it is suggested that the following three points should form the background of the discussion :—(1) The aim in the technical education of the apprentice ; (2) the measures necessary to achieve such aim ; (3) the practical steps to give effect to these measures.

Under the first of these headings it is asserted that the unions have an interest in the education of future craftsmen equal with their interest in the conditions of their employment in industry. The tendency to employ youths on repetition work, denying them the opportunity of sound and practical education, is bound, in the long run, to have a detrimental effect on the personnel, as well as on the product of the industry. It is suggested that apprentice education should be soundly conceived and adequately planned, so as to enable those capable of using the opportunity to become equipped for the highest possible positions in the industry, science, or technical education itself. The aim should be to provide for those who desire merely to become better craftsmen, as well as for those who aspire to the highest possible positions in the industry.

The measures necessary to achieve these aims are held to comprise :—

(*a*) A national scheme of technical education under Government control.

(*b*) The separation of apprentice training from industry proper. This point, it is held, is the crux of the proposals. The paramount concern of managements in the industry is necessarily that of production, and the attention given to training occupies quite a subordinate place, except in a few firms where special attention is paid to training. Further, an apprentice who is learning and creating his own picture of the industry should not have his attention distracted by piecework difficulties or any of the other irritations attendant on production or be involved in any system of payment by results.

(*c*) The adaptation and extension of the present Ministry of Labour centres for practical training in association with the technical colleges and their equipment to be thoroughly adequate and up to date.

(*d*) Two years' practical and two years' theoretical training as a full course is suggested as a base for discussion. It is, however, the opinion of the committee that these periods should be capable of adjustment to the individual needs of the student and the progress of the student should determine the time to be spent on practical or theoretical training.

(*e*) The practical training to be given in centres catering for a limited area of industry and the colleges should cater for the same area and concentrate on the specific industry for that area.

(*f*) The centres to be jointly controlled by the State, the employers, and the unions.

(*g*) The colleges, as well as the centres, to be staffed by teachers with adequate practical as well as theoretical qualifications. Having regard to the rapid changes in industry, teachers should have refresher courses to keep them fully informed of industrial developments.

(*h*) The cost of the training scheme to be borne jointly by the employers and the State.

(*i*) Technical training should be open to all who by preliminary tests are able to prove that they would profit by the training. It should be graded to suit the limitation of each individual student. Where an apprentice would not respond to the full course of training, he would be returned to industry in accordance with his grade.

(*j*) Apprentices who complete the full course successfully to be given a qualifying certificate, which would be a recognised standard of competence and would be awarded by the joint controlling board.

To give effect to the decisions of the conference it is suggested that each body represented at the conference should be free to pursue the results of the discussions in its own way, but that as regards the items agreed upon by the conference, representations should be made to the Board of Education and to other organisations prepared to assist in giving effect to the agreed proposals.

FUSION WELDING OF WROUGHT ALUMINIUM ALLOYS.—Although aluminium has been welded successfully for some forty years, there are still a great many in industry who are not familiar with the technique required for fusion welding of aluminium, whilst even less is known about the welding of the alloys. On this subject a fifty-two-page booklet, entitled "Fusion Welding of Wrought Aluminium Alloys," has been published—price 1s.—by the Wrought Light Alloys Development Association, 63, Temple Row, Birmingham, 2. The booklet deals first of all with the underlying reasons for the various difficulties encountered by operators inexperienced in the welding of aluminium. For example, the reasons for the difficulty of seeing exactly when fusion takes place, and the necessity for using flux mixtures of a certain type are explained. It then describes how the characteristics of the metal affect the welding procedure required for each of the fusion processes. A table is included summarising processes recommended for each type of aluminium alloy. In addition to full descriptions of the oxy-acetylene and other oxy-gas methods, details are given of the metallic arc process, as well as several other processes not hitherto described in publications of this nature, such as the Weibel and Technotherm methods. The booklet is very fully illustrated with both photographs and diagrams, particularly on those pages devoted to the preparation of the work, and the various welding techniques—leftwards, vertical upwards, &c. Flux compositions are summarised and the methods of finishing, including removal of flux residues, are detailed.

Some Tensile Shock Properties of Carbon Steels*

By P. V. WARNOCK, Ph.D., F.R.C.Sc.I., M.I. Mech. E., and J. B. BRENNAN, Ph.D.

(*Continued from page 207, September 10th*)

SINGLE-SHOCK TESTS

As shown in Tables II to XI, several single-shock tests were carried out for each steel. The 0·12 per cent. carbon steel was the first material to be tested, and five single-shock results were obtained. The scatter or maximum departure from the mean value was approximately 2 per cent. The consistency of these results led to the decision that three single-shock tests would be sufficient for each steel.

To compare the energy required for rupture by a single shock with the energy absorption

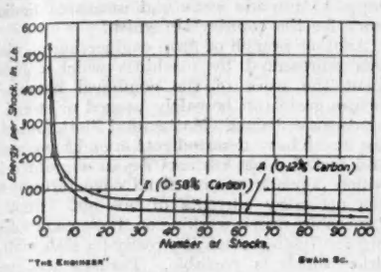


FIG. 5—*Repeated Shock Tests. Relation of Energy Absorbed per Shock to Number of Shocks for Rupture*

by gradually applied stress, a specimen of each steel was ruptured in a Riehlé screw-testing machine.

The average values of the single-shock energy and the corresponding values of the static energy are given in Table XII. The ratio of single-shock energy to static energy is almost unity for the steels with the least and greatest carbon content. These two results are in agreement with those obtained by Smith and Warnock[1] for Lowmoor iron. It is significant, however, that the values of single-shock energy, including that obtained for Lowmoor iron, are less in each case than the corresponding static values—results which are at variance with those of other investigators, such as Blount, Kirkaldy, and Sankey,[2] Staton and Bairstow,[3] Wélikhow,[4] and Breuil.[5]

To check up possible sources of error, the Riehlé machine was calibrated up to a maximum load used in these tests. The maximum error in this range was 10 lb. in 4000 lb., or 0·25 per cent. The residual energy dynamometer had been calibrated by an absolute method. No appreciable rebound was observed throughout the tests. Since the single-shock energy absorption was in each case less than the corresponding static energy, the difference could not be due to loss of energy at the striking surfaces. It is within the bounds of possibility that the differences in the values of the single-shock and static energies for the 0·12 per cent. and the 0·63 per cent. carbon steels were due to errors inherent in the testing technique. There is no variable, however, that would permit the few per cents. difference in value for the 0·12 per cent. and 0·63 per cent. carbon steels and at the same time allow for the energy difference for, say, the 0·37 per cent. carbon steel, a difference of approximately 23 per cent. between the static and single-shock values.

Referring again to Table XII, the average extensions obtained in the single-shock tests are, with the exception of those for the 0·47 per cent. and the 0·58 per cent. carbon steels, slightly less than the corresponding static values. It has been pointed out by Brown and Vincent[6] that variations in elongation are more important in determining the energy absorption than variations in tensile strength. The variation between the values of reduction of area obtained by both methods of testing (Table XII) is small and in agreement with the now generally accepted fact that there is no difference in the percentage reduction of area in the static and single-shock or impact tests.

There was no appreciable difference in the nature or appearance of the fractures of the corresponding specimens ruptured by single-shock and by static means when examined by the naked eye, except in the case of the 0·63 per cent. carbon steel. With this steel the shock fractures were dull in appearance and the static fractures had a bright crystalline appearance with a full patch at the centre of fracture. All the specimens were cut from the same bar.

REPEATED-SHOCK TESTS

Fig. 5 shows the nature of the curves obtained by plotting the value of the energy absorbed per shock against the number of shocks for rupture. The two curves drawn are for the 0·12 per cent. and the 0·58 per cent. carbon steels. These curves possess the characteristics of stress endurance curves and are similar to that previously obtained for Lowmoor iron[1] and to those published by Stanton and Bairstow.[3]

To elucidate the properties of the steels under repeated-shock loads, curves were plotted connecting log H and log N, where H is the height of fall of the tup and N the number of blows necessary for rupture. The logarithmic curves are shown in Fig. 6, A to J; a reproduction of the corresponding curve for Lowmoor iron[1] is included. It would be possible in a few cases to draw a continuous curve which would lie evenly between the points obtained from the tests. Consideration of the related positions of the points of stress endurance curves plotted on logarithmic paper and of the curves obtained for Lowmoor iron[1] convinced the authors that straight lines through the points gave a more satisfactory curve in each case. From the individual logarithmic curves for the 0·29 per cent. and the 0·37 per cent. carbon steels, it is impossible to determine, unless by additional tests, whether the true curves are represented by the dotted lines or the full lines. Examination of the other curves suggests, however, that the dotted lines represent the true curves for these two steels.

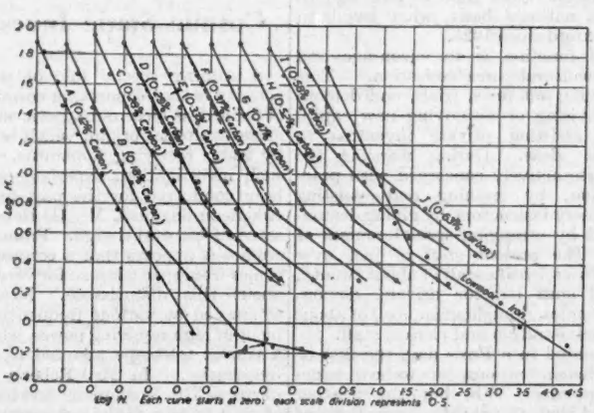


FIG. 6—*Repeated Shock Tests. Relation of Height of Fall of Tup to Number of Blows to Fracture*

To facilitate comparison of the relative energies of the shocks required to fracture specimens of the steels after a given number of blows, Fig. 7 was prepared. In the single-shock tests the energy required to fracture the hardest steel was slightly less than that required to facture the softest steel. Fig. 7 reveals, however, that in tests consisting of as few as ten shocks for rupture, the energy absorbed per shock is greater for the 0·63 per cent. than for the 0·12 per cent. carbon steel. In general, as the number of shocks for rupture increases, the characteristics of the single-shock curve are replaced by characteristics more akin to the values of the proof resiliences of the materials. This is in agreement with the results of Stanton and Bairstow[3] for bending impact tests on notched specimens, though the method of testing here adopted appears to lay more emphasis on this reversal of characteristics and to bring it about in a smaller number of shocks.

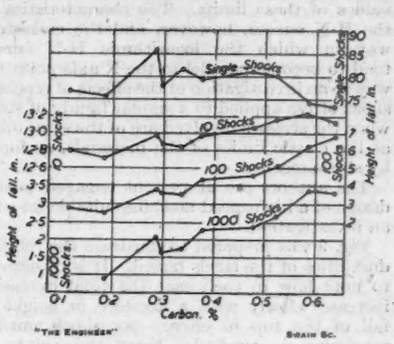


FIG. 7—*Comparison of Relative Energies of Shocks Required for Fracture After a Given Number of Blows*

Observation of the changes in slope of each curve, especially in the case of the 0·18 per cent. carbon steel—Fig. 6 (B)—gives rise to speculation as to whether each curve will eventually become parallel to the N axis and thus give an endurance limit for each material under these conditions. It was assumed by Stanton and Bairstow, probably from the asymptotic nature of the curves and the similarity which exists between curves derived from repeated-impact and stress endurance tests, that a limiting resistance to impact did exist. This assumption was substantiated by some repeated-impact tests carried out by them in conjunction with microscopic examination. It seems, however, that conclusive evidence of the same nature as that in existence for gradually applied stress fatigue limits is still lacking. Further, if such limits do exist, it has yet to be determined whether values obtained by using plain specimens would arrange materials in the same order as values found when using notched specimens.

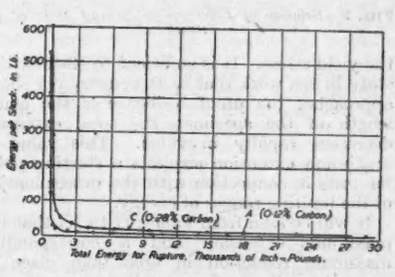


FIG. 8—*Relation of Energy Absorbed per Shock to Total Energy for Rupture*

Referring to the "total energy for rupture" columns in Tables II to XI, there is a drop in value of the total energy between two consistent adjacent values in several cases. The amount of excentricity was small in each case, a matter of a few per cents. To determine whether this was due to lack of homogeneity in the materials or whether they are critical values in the total energy range, values covering the

* The Iron and Steel Institute—July—Abstract.

range tested were taken from the log H/log N curves of the materials in question, and a series of total energies for rupture was estimated from those values.

The values of total energy so obtained were consistent, and when plotted against the energy per shock gave smooth curves, as indicated by the curves for the 0·12 per cent. and the 0·28 per cent. carbon steels shown in Fig. 8. The reasonable conclusion is that the observed inconsistencies were due to lack of homogeneity in the materials. Incidentally, the curves in Fig. 8 are an additional indication that the logarithmic H-N curves are correct as drawn. The total energy curves are also, of course, of an asymptotic nature and emphasise the possibility of a limiting range of energy.

It is not within the scope of this paper to prove beyond doubt the existence of limiting ranges of energy for the steels tested or to determine values of these limits. The characteristics of the H-N curves, however, and the consistent way in which the logarithmic H-N curves tend to become parallel to the N axis point the way to an investigation of the effects of repeated shock stress applied to a similar family of steels when the stresses involved are of the same order as the elastic limits of the materials, as found by static means.

The authors are at present engaged on the design of a high-speed machine suitable for such an investigation.

Fig. 9 was prepared to illustrate the relative ductilities of the steels tested. It is of interest to note how in each case the total extension increases slowly with a decrease in height of fall of the tup or energy per shock until a maximum is reached. From the points of maximum total extension the curves fall away rapidly as the height of fall is further decreased. Unfortunately, sufficient data are not available at present to determine whether the energy represented by the value of H at which maximum total extension takes place has any direct connection with either the proof resilience or the work done in straining the specimen up to

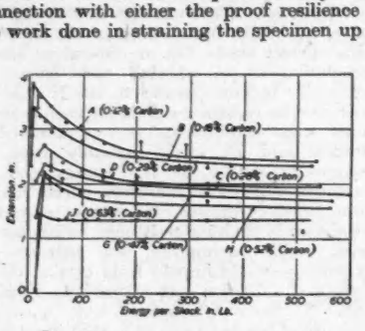


FIG. 9—*Relation of Extension to Energy Absorbed per Shock*

the yield stress. It is sufficient to state at this stage in the work that as the energy per shock approaches the proof resilience of the gauge length of the specimen the total extension decreases rapidly in value. This value of maximum extension suggests a starting point for tests in connection with the determination of the limiting ranges of energy.

It will be seen from Tables II to XI that the maximum extension and a corresponding maximum reduction in area take place at approximately the same value of energy per shock. The difference between the static extension and the maximum total or resultant extension under repeated shock decreases with the carbon content of the steel, and varies between approximately 20 and 50 per cent. for the specimens tested. The difference between the static reduction of area and the maximum resultant reduction of area under repeated shock varies in a similar way between limits of approximately 3 and 15 per cent. The appearance of the fractures of the 0·12 per cent. carbon steel was similar throughout the tests on this steel. For the range of steels from 0·18 to 0·52 per cent. of carbon, the fractures were more ragged and the cone and cup less defined as the height of fall decreased. For the 0·58 per cent. and the 0·63 per cent. carbon steels an area, bright crystalline in appearance, increased with decrease in height of fall until the plane of fracture was completely crystalline in appearance. When the height of fall represented an amount of energy approaching the proof resilience, cleavage planes, at right angles to the centre line of the specimen, were clearly visible in several cases. It is worthy of note that the great majority of the specimens fractured at the centre of the gauge length, even when cleavage was apparent at other planes.

CONCLUSIONS

From a survey of the work described, the following points appear to be of primary importance :—

(1) The ratio of the single-shock energy to the static energy varies with the carbon content of the steel.

(2) The elongation of a specimen of carbon steel when ruptured by a tensile shock may be less than the static elongation, while the reduction of area does not vary with the method of testing.

(3) From the nature of the tensile shock endurance curves there appears to be a limiting range of energy which may be applied an unlimited number of times without causing rupture.

(4) In a multi-shock test, as the number of shocks to cause rupture increases, the resultant extension and reduction of area increase to a maximum at the same value of energy absorption per shock. Further increase in the number of shocks to cause rupture is accompanied by a rapid decrease in both values of ductility.

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[1] Smith and Warnock, *Journal* of the Iron and Steel Institute, 1927, No. II, page 323.
[2] Blount, Kirkaldy, and Sankey, "Proceedings" of the Institution of Mechanical Engineers, 1910, page 715.
[3] Stanton and Bairstow, "Proceedings" of the Institution of Mechanical Engineers, 1908, page 889.
[4] Wölikhow, International Association for Testing Materials, Fifth Congress, 1909, paper No. III (8).
[5] Breuil, International Association for Testing Materials, Fifth Congress, 1909, paper No. III (5).
[6] Brown and Vincent, "Proceedings" of the Institution of Mechanical Engineers, 1941, Vol. 145, page 126.

The Mechanisation of Agriculture

THE National Institute of Agricultural Engineering, in co-operation with the Ministry of Agriculture, has recently organised a series of field and shop demonstrations at its new headquarters at Askham Bryan, York. This is a branch of the Ministry of Agriculture, which was set up rather more than a year ago to expand, on a national basis, what has been going on at Oxford since 1925.

Its general function is to encourage and develop agricultural mechanisation. This involves carrying out tests, trials, and demonstrations; devising or improving new equipment; and assisting private inventors to develop their ideas. During wartime the Institute is also actively concerned with practical education, by training and assisting county machinery instructors, by giving demonstrations, and by arranging special courses of instruction. The present staff of just over eighty includes a scientific staff of about twenty, an industrial staff (tractor drivers, demonstrators, mechanics, draughtsmen, &c.) of about fifty, and administrative and clerical staff.

What amounted to a Press day, the first of the series of demonstrations, was to have taken place on September 10th, but the weather proved so bad that all field demonstrations of tractors and implements had to be cancelled, and the visitors had the better opportunities of seeing what the staff is doing within its own walls.

First there is one fine block, comprising a small power-house, a well-equipped machine shop with a welding plant and a woodworking shop. These flank a bigger and loftier assembling shop, where were under construction a N.I.A.E. version of an ingenious potato harvester, invented by a farmer in North Scotland, and made last season for his own use. Crude in construction and for the most part of wood, it worked. Now, the N.I.A.E. is converting the potato grower's invention into an engineer's job. Another example along similar lines is an experiment, well under way, to provide a continuous farmyard manure loader. This idea originated in the Institute, and if it works out as conceived it should "solve the problem of loading farmyard manure direct from the foldyard into carts or trailers."

Some idea of what the Institute hopes to achieve in the future was shown in the splendidly equipped drawing-office. Here were staged drawings of machines, under way, or "not yet under construction." Among these were a kale harvester to cut and deliver the kale into a cart or trailer; a beet top collector to save the green heads for the silo; a furrow depth gauge to facilitate tractor tests and help the judges in ploughing matches; and lime spreaders, one so big as to be rated at 3 tons and another "which most farmers could get made locally from the rear axle of a car." This last is one example of the way the Institute hopes to provide ways and means of finding work for the countryside smith.

Another branch of farm engineering on view was represented by machines which complement the work of the combined harvester. Before grain can be safely bagged or stored it needs some drying. Mather and Platt, Ltd., for the nonce have deserted cotton and have made and installed at Askham Bryan a grain drier which depends upon a fixed coke furnace for the necessary currents of hot air. Another Lancashire firm is working on the same problem, but the Institute has also ready for test another drier which is portable. Perhaps the most interesting bit of work is concerned with the problem of shearing beet seed "kernels," so as to get the seeds out of it singly. If one sows a single sugar beet seed, one, two, three, four, or even five plants may germinate, most of which must be singled later in the season. The problem has been to disintegrate each "kernel" so as to put single seeds into the drill. Here British and American research has been co-operating with the latter responsible for originating the work. Grinding had to be avoided and yet, curiously enough, the solution of the problem points to the combination of an abrasive wheel with a cracking block of hardened steel. The passage of the beet seed through the shearing machine is facilitated by the rough periphery of a grinding wheel which does not grind.

If Askham Bryan is developed along the lines indicated, it may prove to be the nursery of farm machinery not yet called for, or even thought of, by agriculturists and engineers.

Cosmic Static Investigations

A HIGHLY special line of study in radio-activity is that concerning cosmic static, which is defined as electro-magnetic radiation having extra-territorial origin, which may be detected by radio receiving apparatus. As a part of such investigation, experimental research has been conducted for the past few years by an American engineer, Mr. G. Reber, using apparatus of his own design. From this and other studies it appears that a certain type of static comes from space, but so far very little is known about this disturbance. Measurements are attempted at various frequencies, with equipment of high resolving power, which is, in effect, a transit telescope adapted to work at radio frequencies. In Mr. Reber's apparatus the mirror is 31ft. in diameter and has a focal length of 20ft. Any radiation captured actuates a meter having an automatic recording cahrt. Tests have been made on various bright stars, but so far without measurable response. Matter that is continually thrown off by the stars tends to expand and fill the interstellar space with a tenuous gas at extremely low density, so that space is filled with positive particles and high-speed electrons of a few volts energy. In a paper before the American Institute of Radio Engineers it is suggested by Mr. Reber that cosmic static is the equivalent of thermal agitation in which all space is the conductor and the input terminals of the detecting equipment are projected by an antenna system to some far-distant part of space.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

The International Tin Control

An article in *Tin*, published by the Tin Producers' Association, defending the international control of the metal, which began in 1931, as a result of the depression in the industry, and is administered and enforced by the Governments of the countries concerned, points out that "the need for tin control, although accentuated by the special circumstances of the great depression, is not confined to times of economic stress, but is inherent in the general conditions which characterise the production, consumption, and distribution of tin. This need arises from several factors. The supply of the metal cannot be adjusted quickly to changes in demand, although the latter is very irregular. The demand for tin for consumption purposes, however, is exceptionally inelastic. The cost of the tin content bears so small a proportion to the total cost of any article of which it is a component that the demand for the metal is particularly unresponsive to changes in the price. It is also the fact that, despite the most intensive search throughout the world, the known reserves of tin in the ground are insignificant in quantity. In these circumstances the violent short-term fluctuations in the price of tin which prevailed before control must have been largely attributable to the machinery of distribution. This was canalised through the London Metal Exchange. While this market undoubtedly provided valuable hedging facilities, it also attracted the sort of speculation which is not based on real changes in the supply-demand equation, but is governed by rumours, often unreliable, of possible gluts and shortages. About ten times the amount of tin actually available was bought and sold on the Exchange. The control of output by means of production quotas ensures a balance as between supply and demand over relatively long periods. But quicker methods are needed to maintain price stability over shorter periods. This is the function of the 'Buffer' Stock, which had a beneficial effect even in its earliest form. Finally, the speculative price oscillations which occurred before the introduction of control were due in large measure to the absence of adequate statistical knowledge of production, consumption, and stocks. The complete statistics collated and published by the International Tin Research and Development Council did to a large extent eliminate the dangers of rumours." Engineers will agree with all that is said in favour of stability of prices; but many cases will occur to them in which the cost of tin bears anything but an insignificant relation to the total cost of the product in the manufacture of which it is used.

The Pig Iron Market

Few complaints are heard regarding the pig iron position in Great Britain. There has always been sufficient to meet the requirements of the firms engaged upon essential work, but at times the position has been somewhat stringent and allocations have been carefully pared. The production of pig iron now, however, is sufficient to meet the demand from all consumers engaged upon work arising from the war, although supplies are not available for ordinary commercial work in any quantity. The position in the low and medium-phosphoric pig iron sections has become much easier as a result of the arrivals in this country of high-grade Mediterranean ore. The demand for hematite, however, is still well in excess of the quantities available, and parcels of this iron are only released when no other description will serve the purpose for which it is required. The improvement in the supply position of refined iron, however, has enabled the engineering and allied foundries to obtain larger supplies, which are used to a considerable extent as a substitute for hematite. Ordinary No. 3 foundry iron is meeting with a substantial demand from engineering foundries and from jobbing foundries, whilst the light castings foundries are taking larger supplies of high-phosphoric pig iron, since more of them are incorporated in the war effort and this class of pig iron is being used to an increasing degree for purposes for which before the war it would not have been considered suitable. The light castings industry, however, is operating at a much lower rate than is usual in peacetime, and it is not expected that this position will alter greatly during the war. Stocks of foundry iron have been accumulated at a number of the consuming works and the position in this department is distinctly easier. There is, of course, a heavy demand for basic pig iron for steel making, but the steel works are obtaining all the pig iron they require and there seems no likelihood of any tightness developing in this section of the market. On the whole, the foundries are fairly well placed, and are obtaining full supplies against running contracts.

Scotland and the North

The Scottish steel works are meeting with a more intensive demand for steel than at any time this year. The call for steel required in shipbuilding is particularly heavy and a huge volume of business in plates is being transacted. In addition, the tank makers and locomotive builders are increasing their demands upon the plate makers, who for the most part have already booked up their output to the beginning of next year. The sheet makers have been called upon to assist in meeting plate requirements by devoting some of their production to light plates, and this branch of the industry also has some months' work in hand. Recently there has been a revival in the request for sheets, but consumers have not found it easy to fill their requirements unless they are prepared to wait for extended delivery. The Scottish marine engineers and power plant makers are busy and their requirements of steel total a large tonnage. The works producing sections are well employed and most of them require rather lengthy delivery periods. This, however, does not apply to the larger sections and in many cases consumers have been able to place orders for delivery in the fourth period. An active business is passing in steel bars of all sizes, although the demand is predominantly for the smaller classifications. There is a particularly active demand for light angles for the smaller types of vessels and for certain descriptions of mobile Army equipment. In Lancashire the consumption of steel is on a particularly heavy scale. The engineering industry, which is almost entirely engaged on war work, is a particularly heavy consumer. Bars of all sizes are readily passing into consumption, and there is a particularly large volume of business in bright bars. The call for plates, however, is still the chief feature of the market and shows no sign of declining. There is, however, some irregularity in the position of the steel works, and in some cases works appear to be better placed for giving reasonably early delivery against new contracts than others. Cases in which makers are anxious to do fresh business, however, are practically non-existent. There is a large tonnage of work in hand at the steel works on the North-West Coast and production in this locality is understood to have increased in the past few weeks. The output includes heavy and light rails, billets, and structural steel.

The North-East Coast and Yorkshire

From now until the end of the year the steel works are assured of active business conditions. The demand for plates is not likely to relax and the requirements of the shipbuilding industry alone are sure to be on a huge scale, whilst other industries, such as locomotive builders, wagon makers, and heavy engineers, are also taking up abnormal quantities. Lately there has been a heavy demand for thin plates, towards meeting which the sheet works have contributed considerable tonnages. It is fortunate that the position in the semi-finished steel department is satisfactory, and it is probable that the home works have never before turned out such large quantities. Although there is a big demand for sheet bars, the call for billets is the more insistent, and some works which have been producing sheet bars only have now been put on to produce billets and this has eased the position of the latter product. The re-rolling industry is also assimilating defectives, crops, and similar material, and its operations are not hampered by lack of semi-finished material. In most departments of the steel trade the only orders which are being accepted for earlier delivery than the first quarter of next year are those for most urgently required material. The demand for light structural sections continues to expand and most of the works producing this class of material have full order books for delivery up to the early part of 1944. The demand for heavy joists and sections, however, is only moderate. The Yorkshire steel industry is operating at capacity, and now that allocations have been made for the fourth quarter there has been a steady stream of new contracts reaching the works. In the basic steel section of the industry operations have been intensified as much as possible, but previous to the opening of the new quarter many of the works' order books were badly congested. There is also a strong demand for acid carbon steel, which is taxing the resources of the producing works, but so far the efforts of the industry to meet the intensified demand have proved successful. The hint recently given by the Minister of Production that there will be a greater concentration on the production of aircraft has raised expectations that there will be an increase in the demand for alloy steel. The production of this description was increased only a short time ago. The demand, however, quickly overtook the supply, and the probability is that even greater pressure will be exerted upon manufacturers to meet still heavier needs. All the steel foundries in the Yorkshire industry are fully employed for the remainder of the last quarter of the year, and the strong demand for steel castings keeps the whole capacity of this branch of the industry working at high pressure. There is also a big demand for drop forgings, but all kinds of forgings are in urgent request.

The Midlands and South Wales

The iron and steel works in the Midlands have been working under intense pressure to meet the insistent demand from consumers. The requirements of the latter appear to be increasing as the year progresses, although there is evidence of the strain at which the works are operating by the gradual increase in the delivery dates quoted for several descriptions of steel. The plate mills, which have been working under particularly strenuous conditions for a long time, have experienced no relief from the demand from the shipyards, locomotive builders, and heavy engineers, and, in fact, there does not seem likely to be any relaxation in the pressure from consumers for an indefinite period. The alloy steel makers are expecting a further increase in the requirements of the aeroplane manufacturers. Structural steel is in great demand and the volume of business in the lighter sections is greater than at any period during this year. Constructional engineers for the most part are fully employed, and although their concentration upon war production has resulted in great changes in the class of work they are called upon to undertake, it has increased, if anything, the demand from this industry for steel materials. The call for heavy joists and sections, however, is rather quiet, as there is not so much work on factories and extensions as in the earlier part of the war. The re-rolling industry is busy in all its branches and is turning out substantial quantities of small steel bars and sections, whilst the sheet works have enough work in hand to keep them fully employed for some months. Great activity prevails in the South Wales iron and steel industry. The tinplate trade is quiet, more as a result of the regulations limiting the manufacture and use of tinplate than for any other reason, but considerable quantities of sheet and tinplate bars are being produced and pass rapidly into consumption. All the South Wales iron and steel works are maintaining their deliveries; although this necessitates keeping the plant employed at high pressure. There seems little prospect of the industrial position becoming easier during the present delivery period.

Iron and Steel Scrap

The iron and steel scrap market has changed little over the past week or two. The demand is still principally for the heavy and better grades of iron and steel scrap, and it is difficult to meet consumers' full requirements of this quality, since the supplies reaching the market have not increased. There are liberal supplies of light descriptions, however, although these are not readily taken up, but consumers are showing more interest in some sorts. The scarcity of supplies of good heavy mild steel scrap cut to furnace and foundry sizes appears to be growing, and any parcels coming on the market are quickly taken up. There is an active request also for bundled steel scrap and hydraulically compressed steel shearings, and in this department also consumers appear willing to accept all the material offered. Steel turnings are arising in considerable quantities, but although there are liberal supplies the demand seems to be concentrated upon the prepared descriptions, whilst a comparatively small business is passing in the light and bushy kinds. Good quantities of mixed wrought iron and steel scrap for basic steel furnaces are passing into consumption, particularly good heavy material. As in other descriptions of scrap, there is only a moderate demand for the lighter classes. A steady trade is passing in compressed basic bundles and there are indications that the demand for this class of scrap will expand in the near future. There is a ready sale for most kinds of cast iron scrap, but it is not easy to obtain heavy parcels. Supplies of light cast iron scrap are not freely available, and this limits the volume of business in this department. There is an active request for good cast iron machinery scrap in cupola sizes and parcels coming on the market are quickly taken up. Quantities of alloy steel scrap and special analysis steel scrap are coming forward on a somewhat restricted scale but are meeting with an active demand. The forges appear to have accumulated good stocks of the better class of sheared scrap material, and for the time being are showing comparatively little interest in parcels of unsheared heavy wrought iron scrap.

Notes and Memoranda

Rail and Road

THE LATE LIEUT.-COLONEL TURNER.—We note with regret the death, in New York, of Lieut.-Colonel Clive Mansfield Turner, head of the British Railways' Organisation in New York. He was fifty-nine years of age.

AN UNUSUAL ROAD.—One of the world's unique roads is that connecting Zandery Field, Dutch Guiana, with the capital city of Paramaribo, a highway sometimes called the "Million-Dollar Highway" or the "Most Valuable Road in the World." *Engineering and Contract Record* says that this road is built on a base of mahogany and surfaced with bauxite, and that it was constructed in record time by U.S. Army Engineers. There is no estimating the intrinsic value of the materials which went into its construction, but in Dutch Guiana they are the cheapest and most readily available.

C.P.R. WAGONS.—The Canadian Pacific Railway is expecting to save approximately 850 tons of steel by the use of plywood in the construction of 750 new wagons now on order with the National Steel Car Company, the Canadian Car and Foundry Company, and the Eastern Car Company. In 500 of the new wagons, ⅜in. plywood has been specified for the outside steel sheathing formerly used, the inner wood lining being retained. The remaining 250 wagons will use 1½in. wood put inside the steel side posts, replacing both the steel sheathing and inner wood lining. The plywood is hot-pressed, resin-bonded, and is bolted to the steel side posts. The wagons will be welded instead of riveted, with lighter castings throughout.

ARTICULATED LOCOMOTIVES.—Ten articulated 2–8–8–4 locomotives, recently delivered by the Baldwin Locomotive Works to the Duluth, Missabe and Iron Range Railway, with a tractive force of 140,000 lb. each, are among the most powerful articulated units in the country. This company conducts a heavy movement of ore from the Vermilion and Mesabi ranges in Minnesota to the docks at Duluth, Lake Superior, except during the mid-winter season, when ice on the Great Lakes makes navigation impossible. The length of run is not great, and the journey from the mines to the docks and back can be completed in ten to twelve hours. To work the traffic with a minimum locomotive stock, these engines, with their eight predecessors delivered in 1941, are designed to make the round trip, with loaded trains of 6000 gross tons, without refuelling, and with no water stops between terminals. For this purpose they are provided with Commonwealth tenders of the rectangular "U" type, carried on fourteen wheels (five fixed axles and leading bogie) which accommodate 26 tons of coal and 25,000 gallons of water. *The Railway Gazette* says that these 2–8–8–4 locomotives each have four 26in. by 32in. cylinders, 5ft. 3in. driving wheels, 6032 square feet tube and flue heating surface, 726 square feet fire-box heating surface, and 2770 square feet superheating surface, a combined total of 9528 square feet, 125 square feet grate area, 240 lb. per square inch working pressure, and a weight in working order of 312½ tons, of which 252 tons are available for adhesion. The tender, fully loaded, weighs 195½ tons, making a total for engine and tender of 508 tons. Valve gear is of the Baker type, and the 12in. piston valves have maximum travels of 8in. (front engine) and 7½in. (rear engine). The boiler is of the straight-top type, 58ft. 7½in. long and 8ft. 8in. in diameter. The total engine wheel base is 67ft. 2in. and that of engine and tender 113ft. 4in.

Air and Water

THE LIFEBOAT SERVICE.—The Royal National Lifeboat Institution has revealed that 5288 lives have been rescued by its lifeboats during the four years of war.

CHINESE SHIPPING.—It is reported from Washington that two "Liberty" ships have been assigned to the Chinese Government for the duration of the war by the United States War Shipping Administration.

CANADIAN VEHICULAR FERRY.—The Canadian Minister of Transport recently announced in the House of Commons at Ottawa that plans are in hand for the construction of a combined ice-breaker, railway, and passenger vehicle ferry to operate between Prince Edward Island and the New Brunswick mainland.

H.M.A.S. "SHROPSHIRE."—A cruiser of the "County" class, H.M.S. "Shropshire," has been presented by the British Government to the Commonwealth Government of Australia. This marks the fulfilment of a promise made to the Australian Government after the sinking of H.M.A.S. "Canberra" last year.

LONG MILEAGES OF SHIPS.—Some interesting figures have recently been disclosed concerning the distances covered by British ships during the war. The destroyer "Foxhound" is said to have steamed 240,000 miles, and an oil tanker of 12,000 tons, the "British Confidence," 243,000 miles. Three of the Union-Castle motorships have each travelled 300,000 miles, and three others of the same line have covered more than 250,000 miles each.

SWEDISH M.S. "INDUSTRIA."—The Lindholmen Shipyard, of Göteborg, has recently launched the "Industria," a motorship of 2900 tons deadweight, for the Swedish Lloyd Shipping Company. The vessel, which is of the open shelter-deck type with soft-nose and cruiser stern, is the seventh in a series of ships of the same type ordered by these owners. The propelling machinery consists of one single-acting, two-stroke, six-cylinder oil engine of the firm's own make, estimated to give a speed of 13¼ knots fully loaded.

Miscellanea

CABLE-MAKING IN THE ARGENTINE.—A rolling mill for dealing with copper ingots has recently been installed at the cable works of the Sociedad Pirelli at Mataderos, Argentina, and electric wires and cables of all sizes are now being produced, from insulating wires of 0·02 square millimetre section up to 150-kV power transmission cables. The company has two other works in the country, at Buenos Aires and Flores, covering an area of 20,000 square metres.

NEW ZEALAND WOODS.—From New Zealand comes the news that a silver beech, indigenous to both islands, is increasing in usefulness and value. Straight in grain, easily worked and strong, it makes excellent rifle stocks, and some of it has been shipped to the United Kingdom. Another first-class timber tree is Insignis Pine, the output of which has more than doubled in five years. This is used for making ammunition boxes, grenade cases, and cases for use in lorries and trucks.

BRAZIL'S ALUMINIUM INDUSTRY.—According to *Iron Age*, the first generators and transformers for power stations which will generate 6000 kW for Brazil's new aluminium industry are now being installed. The Brazilian Government laid plans in 1940 to speed the development of its eighty-one known deposits of bauxite, which were estimated to contain approximately 150 million tons. In Minas Geraes, a Brazilian concern, Eletro Quimica Brasileira, made plans to enlarge its power facilities at three points—Saramenha, Caboclo, and Funil—to serve a projected aluminium plant near Ouro Preto.

INSTITUTE OF METALS.—The thirty-fifth annual autumn meeting will be held on Wednesday, September 22nd, at 4, Grosvenor Gardens, London, S.W.1, at 3 p.m. After the formal business the following papers will be presented for discussion:—"New Methods for the Examination of Corroded Metal," by F. A. Champion; "The Surface Protection of Magnesium Alloys," by N. Parkinson and J. W. Cuthbertson; "The Structure of Rolled and Annealed Aluminium as Revealed by X-Rays," by E. E. Spillett; and "Directional Characteristics of Single-Texture-Structure Copper Strip," by Maurice Cook and T. Ll. Richards.

FUEL ECONOMY IN THE CHEMICAL INDUSTRY.—The second in the series of technical discussions in Manchester on practical aspects of efficiency in the utilisation of steam and power in chemical processes, arranged jointly by the Association of British Chemical Manufacturers with the co-operation of the British Chemical Plant Manufacturers' Association, will be held on Wednesday, September 22nd, at 5 p.m., at the Engineers' Club, Albert Square, Manchester. The subjects for the second discussion will be "Storekeeping of Steam" and "Water Treatment and its Influence on Power Plant Economies." Brief introductions by Mr. A. Milnes (Spirax Manufacturing Company, Ltd.) and Mr. C. J. Carter (John Thompson (Kennicott Water Softeners), Ltd.) respectively will be followed by discussions on personal practical experiences and questions will be welcomed. Non-members of the Association are invited, and should notify Mr. W. Murray (The Liverpool Borax Company, Ltd., Maxwell House, 6, St. Paul's Square, Liverpool, 3) not later than Saturday, September 18th, of their intention to attend.

Personal and Business

MR. W. E. OGDEN has been appointed a director of the Delta Metal Company, Ltd.

MR. H. L. PIRIE has been appointed Chief Fuel Engineer, Ministry of Fuel and Power.

MR. FRANK B. COMMON has been elected chairman of the Clayton Aniline Company, Ltd.

DR. F. J. NORTH has been re-elected President of the South Wales Institute of Engineers.

DR. H. G. TAYLOR has been appointed chief electrical engineer, Philips Lamps, Ltd.

MR. JOHN NEILL has been elected Chairman, and Mr. Allan Stevenson, Vice-Chairman, of the National Association of Marine Engine Builders.

MR. E. BERNARD JONES has been appointed secretary and accountant to Cammell Laird and Co., Ltd., in succession to the late Mr. S. Woodward.

MR. G. H. RAWCLIFFE has been appointed to the Chair of Electrical Engineering at Bristol University, in succession to the late Professor David Robertson.

THE SOCIETY OF MOTOR MANUFACTURERS AND TRADERS, Ltd., has changed its address to 67, Portland Place, London, W.1. Telephone, Welbeck 3364.

THE INSTITUTION OF MINING AND METALLURGY will change its address to Salisbury House, Finsbury Circus, London, E.C.2. as from Monday, September 20th.

SIR NOEL ASHBRIDGE, Controller of the Engineering Division of the British Broadcasting Corporation, has been appointed Deputy Director-General of the Corporation. Mr. H. Bishop succeeds him as Controller of the Engineering Division.

MR. GEORGE KEITH, chairman and managing director of Keith Blackman, Ltd., was presented, on September 9th, by the directors, staff, and workers of the firm with a silver tray and a gold watch chain, to mark the completion by him of fifty years' service with the company. The presentation was made at a large gathering of the company's employees, Mr. W. B. Richards, director and general manager, being in the chair.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Public Lighting Engineers

Wednesday and Thursday, Sept. 22nd and 23rd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Two-day conference.

Association of Special Libraries and Information Bureaux

Saturday and Sunday, Sept. 18th and 19th.—Royal Society, Burlington House, Piccadilly, W.1. Annual conference. 10.30 a.m. (Saturday and Sunday).

Institute of Metals

Wednesday, Sept. 22nd.—4, Grosvenor Gardens, London, S.W.1. Autumn meeting. 3 p.m.

Institution of Electrical Engineers

Saturday, Sept. 18th.—N.E. STUDENTS' SECTION. Visit to L.N.E.R. Traction Sub-station, Pelaw. 2.30 p.m.

Thursday, Oct. 7th.—Savoy Place, Victoria Embankment, W.C.2. Presidential Address, Colonel Sir A. S. Angwin. 5.30 p.m.

Institution of Locomotive Engineers

Thursday, Sept. 23rd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. "The Evolution of Locomotive Valve Gears," T. H. Shields. 5.30 p.m.

Institution of Production Engineers

To-day, Sept. 17th.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "Quality Control," K. W. Macartney. 6.30 p.m.

Sunday, Sept. 26th.—LUTON SECTION: The Library, George Street, Luton. "Forging," R. W. Brocklehurst. 10 a.m.

Iron and Steel Institute

Wednesday, Sept. 29th.—Engineers' Club, Albert Square, Manchester. "Lattice Structures in Relation to Physical Properties of Metals," Dr. W. H. Taylor. 6.30 p.m.

Junior Institution of Engineers

Friday, Sept. 24th.—39, Victoria Street, Westminster, S.W.1. "Daylight Illumination in Factories and Workshops," P. J. Waldram. 6.30 p.m.

Royal Aeronautical Society

Wednesday, Sept. 22nd.—GRADUATES' AND STUDENTS' SECTION: 4, Hamilton Place, W.1. Informal talk by Sir Frederick Handley Page. 6.30 p.m.